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EVOLUTION

A JOURNAL OF NATURE

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Courtesy United States Department of the Interior

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EVOLUTION
A Journal of Nature
For Popular Education in Natural Science
To Develop the Open Mind

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THREE OF EVOLUTION's most ardent supporters whose names appeared on the editorial masthead, have died since the last issue appeared: Dr. Martin Dewey, former President of the American Dental Association, Maynard Shipley, President of the Science League of America, and Dr. Elihu Thomson, Research Physicist of the General Electric Company. All three were valiant champions of popular enlightenment. Let their memories encourage us to carry through to ultimate triumphant success the cause they served so well.

WE ARE PROUD TO ANNOUNCE that Dr. Oscar Riddle of the Carnegie Institution of Washington, Station for Experimental Evolution, joins the Scientific Advisory Board of EVOLUTION. We think our readers will agree that "The Confusion of Tongues" is a real classic in this struggle for Science Freedom.

Miss Lucy Orenstein, a biology teacher in Evander Childs High School, New York City, becomes one of our contributing editors. She has an intense personal interest in evolution, and knows how to convey this interest to beginning students. Her first contribution to our columns is this month's "Question Box."

WHAT'S IN A NAME?

SOME WELL MEANING FRIENDS have advised that it would be easier to make a commercial success of this journal if we changed EVOLUTION to some "less offensive" name. If we were ever to make this change, the logical time was with this first issue after suspension.

It is true that some who now refuse might subscribe for EVOLUTION under some other name, and advertisers might be induced to pay for space. But if we yielded to this commercial pressure to change the name, the pressure would become even greater to leave out the subject matter too, to become merely another journal dealing with nature's "beauties" and "marvels" and sidestepping all such "controversial" subjects as evolution and its implications. The problem would not be solved short of surrender.

No, there is already an ample parade of pussyfooting in this land, without our joining the procession. We believe that there is real need for a popular journal that refuses this compromise with error, that will not equivocate by withholding facts or misusing words to hide their real meaning. It is not our purpose to discover some camouflage that will enable us to exist while leaving superstition to flourish, but to eliminate it from the human mind by helping to spread the light of science.

We have full sympathy with the lone biology teacher, who has to manage the subject under the nose of some ignorant politician-principal and harrassed by a fundamentalist school board. But it would be an ill service to this teacher if we acted as though evolution is something sinister, something to be ashamed of, that must not be mentioned. In the long run we shall serve even this teacher best by coming out boldly with the fact of evolution. If we stand up, others also will find courage to make the stand. So we'll hold the banner high.

In a way, the very suggestion to change the name of EVOLUTION proves the need for this journal. Some professors, sheltered in cloistered college halls, may think that "every intelligent person accepts evolution" and popular education isn't needed, but they are wrong. We hope to carry on until the humblest teacher in the most backward school district has complete freedom to convey to inquiring youth the full meaning of all that science learns regarding Man's place in Nature.

In this endeavor we invite not merely the sufferance but the active co-operation of every reader. —*L.E.K.*

A PERSONAL WORD

AS I'VE MET A MAJORITY of our 7,700 EVOLUTION subscribers face to face I'll address you personally.

First I wish to express appreciation for the courtesy with which you received me, the confidence you showed in me, a stranger who came to your door, and the patience with which you have awaited the appearance of EVOLUTION. I hope you will deem it worth while.

During the five years since the last issue of EVOLUTION appeared I have canvassed for it in practically every city of over 100,000 in the United States and a great many smaller communities, all the larger colleges and universities, and hundreds of high schools in 45 States and in Canada. In securing over four thousand subscribers personally I probably talked about EVOLUTION with over 20,000 persons, traveled 30,000 miles by bus and train, walked at least 12,000 miles and rode an equal distance by street buses and cars. And I am more convinced that there is a need and a real field for EVOLUTION than I was before I started.

Although I did not succeed in finding an "angel" for this enterprise, I now feel that through this field-work a sufficient foundation has been laid to justify resuming publication. Nearly a thousand new subscribers have promised to remit after receipt of the first number; several hundred have told me that they would try to secure additional subscribers; others pledged donations for the Library and Sustaining Fund; many teachers will offer EVOLUTION for sale to students; over a hundred editors have promised reviews of this issue in their journals; a large number of eminent research scientists, writers and teachers have promised material for articles; literally thousands now understand what EVOLUTION hopes to do, wish it well, and will further its work.—*L.E.K.*

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Nature's Upstart: Homo Sapiens

By WILLIAM KING GREGORY

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Professor of Vertebrate Paleontology, Columbia University

IF *Homo sapiens* had not had an aggravated superiority complex he would never have applied the adjective *sapiens* to himself in the face of overwhelming evidence that he deserves rather to be called *Homo inflatus*. The daily course of the sun as well as the rising and setting of the stars suggested that man's home the earth was the center around which the rest of the universe turned. Hence it was but a short step to the idea that man himself was correspondingly important in the cosmic plan.

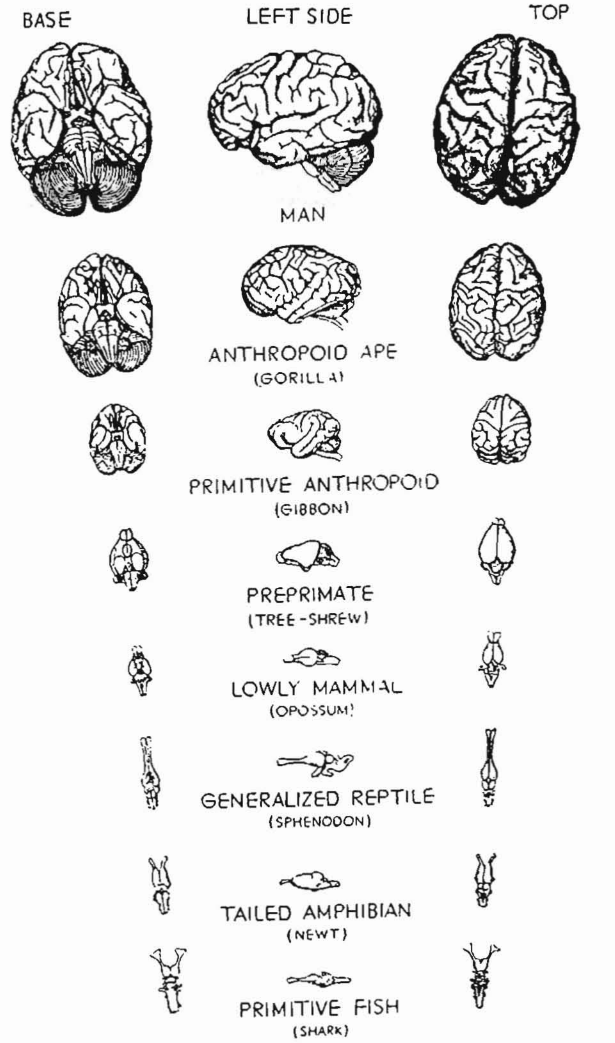
In the mythology of the Greeks the gods were so intensely interested in the affairs of men that they took sides with the opposing heroes and heaven was more disturbed by the disputes following the stealing of one woman than it would normally have been by the sacking of ten cities. Not even Zeus himself disdained the charms of the daughters of men and from such crossings of gods and men sprang various lines of half divine kings. As to the ancient Teutonic deities, one hesitates to dwell upon their all too human frailties; but to people beyond the pale of the magic swastika it is apparent that though some of these good old German gods and goddesses were not exactly all that they should be, they were regarded as ideal companions for the spirits of warrior heroes. The unregenerate *Homo sapiens*, especially in the allegedly civilized countries, has usually imagined his race to be the hero of the drama of creation.

Deflation of Homo Sapiens

For his soul's good, however, I deem it my duty to puncture the bubble of *Homo sapiens*. For it is only after we are all properly deflated and made to realize what miserable sinners we are that we can find the way of redemption from the follies of anthropocentrism.

At this period in the history of science it is assuredly unnecessary to review the evidence tending to show that the earth, far from being in any scientific sense the center of the universe, is not even the center of the solar system. But in spite of the collapse of the geocentric system of astronomy, the anthropocentric view of cosmology has managed to survive in many quarters. Yet in addressing a scientific audience it is not necessary even to summarize the evidence that man was not created specially and apart from other living things but that he like them arose by evolution from earlier and lower forms of animal life.

If this be granted as a general proposition, we are in a position to outline a number of conclusions with regard to the evolution of man, which, if accepted, tend on the one hand to clarify his relations to the rest of nature and on the other hand to explain, at least in some measure, his general pattern of behavior.



RISE OF THE HUMAN BRAIN

From fish to man the forebrain increases in size and complexity. In lower forms it functions chiefly with the smelling nerves. In mammals the upper part of the forebrain, differentiated as the neopallium or new brain, assumes control and, greatly infolded, largely conceals the older parts of the brain.

The forms figured here all live today. Although not ancestral their brains represent a progressive series.

Homo sapiens, like other animals, is a sort of living solar engine, which, unlike the plants, is unable to appropriate for himself the life-giving energy of the sun but must take that energy, in the form of food, from plants or other animals or both. Hence, by the primary law of his nature, he tends to take what he wants when he wants it and, as we shall see later, it is owing only to the beneficial restraints of various social systems that man learns to resist even in part these deep-seated urges to pluck and eat or to kill and eat. Since neolithic times man has by cooperative effort deliberately multiplied his food supplies by the raising of food plants and by the breeding of ruminant animals. Before such a cooperative stage was attained, the human animal had to depend more directly upon his individual equipment as a vertebrate, as a mammal and as an offshoot of the anthropoid division of the order of Primates. Even now the most advanced normal examples of *Homo sapiens* could hardly carry on the daily business of life without benefit of a long series of "basic patents" which man has inherited from earlier vertebrates, to some of which we must refer even if very briefly.

The earliest chordates were already adjusted to the force of gravitation by a dorso-

From Science 83:41 & 69
Jan. 17 & 24, 1936

ventral asymmetry, the neural tube being above the notochord and gut. Like modern fish they were also adjusted for forward progression through the water by means of a bilaterally symmetrical arrangement of the muscle-segments on either side of the midline.

Among other fundamental adjustments of the basal vertebrate type which are retained by man is the backbone itself; this is a jointed axis in which the individual vertebrae comprise checker-like centra formed around the notochord and arches spanning the nerve chord. The functions of the column were complex but may be summarized as follows: first, each segment served as a fulcrum or pivot upon which those in front of and behind it turned; secondly, the arches and processes served as levers for turning the body in the directions of the tendons of the axial muscles. The vertebrae also served as pivots for the ribs, to which were attached the muscle segments of the flanks and back.

Progression through the water in the earlier vertebrate forms was and is today largely by means of lateral undulations of the body as a whole, the fins being at first merely keel-like outgrowths of the body wall. The legs of quadrupeds were merely fleshy outgrowths of the lateral muscles, supported internally by bones secreted in the spaces between the muscle masses. There is strong evidence for the view that the hands and feet of the four-footed or tetrapod vertebrates were formed by modification of the stout pectoral and pelvic paddles of the lobe-finned fishes. In any case, by the time of the Coal Measures the five-rayed appendage had already appeared. Thus the foundations of the decimal system may be said to have been provided by the first amphibians of the Carboniferous Age, some 250,000,000 years ago.

The limbs are bent levers and act like springs and throwing sticks. At first the limbs were short and sharply crooked outward at the elbows and knees, but by the time of the more advanced mammal-like reptiles the body was raised well off the ground and the trackway began to narrow. Very early in the Tertiary period, when mammals became dominant land forms, the ancestors of the Primates are shown by fossils to have been tree-climbing forms with grasping hands and feet. This was the beginning of our prehensile hands, but did we also at one time have prehensile feet? Space is lacking here to discuss this question but it may be said that the convergence of evidence from paleontology, comparative anatomy and embryology affords strong support for the view that the peculiar foot of man has been derived from a primitive anthropoid type with a divergent big toe. This change took place chiefly by the drawing of the big toe towards the others and by the marked lessening in length of the second to the fifth digits inclusive. In brief, there is very convincing evidence that the early Primates ancestral to man were forestliving arboreal animals, and that the immediate ancestors of man, probably through the disappearance of the forest in certain areas in central Asia, had to accustom themselves at first to life on the ground in a more open country. It is difficult to escape the conclusion that man owes the general ground-plan of his foot to his long-extinct anthropoid ancestors but that he owes to his more immediate prehuman ancestors those special modifications of his feet which fit them for his upright posture.

With the assumption of the upright gait new stresses were put upon the backbone, which responded by greatly widening the sacral vertebrae, by forming the so-called lumbar curve and by remodelling the hip bone so as to increase the width of the area for the gluteal and iliacus muscles and at the same time to bring the center of gravity of the thorax more directly above the transverse line connecting the sockets of the opposite femora.

The resultant freeing of the forelimbs from strictly locomotive duties has often been noted, but what is not generally realized is the fact that this great advance in their use as hands is already in full swing among the anthropoid apes, in which it is likewise associated with the ability to examine things closely with both eyes at once.

If space permitted, we might profitably review these matters in much greater detail and we might also follow the evolution of the jaws from their origin as a pair of enlarged gill-bars in the earliest true fishes to their subsequent modification through the varied use of the sheathing bones surrounding the primary or inner jaws. And from this point, which is fully represented in the air-breathing, lobe-finned fishes, in the ancestral amphibians and early reptiles, we could trace the profound transformation of the jaws and teeth during the period of the evolution of the mammal-like reptiles and the emergence of the lower mammals, and finally of man. But as I have described these things in many previous communications to scientific societies, I merely refer to them here in passing, as I desire to touch upon some of the social results of all these changes during the long road of ascent from fish to man.

The Penalty of Being Homo Sapiens

When the ancestors of man left the forests and were changed into primitive men their brains rapidly grew much larger than those of their more backward relatives, the known anthropoid apes. But increased brain power was by no means an unmixed blessing, for though on the one hand it was indeed necessary for permanent advance in the mental world, its possession subjected the owners to a multitude of evils undreamed of in the relatively peaceful and unintelligent world of the anthropoid apes.

We do not have to commit ourselves in advance to any particular theory of the relations between mind and matter, but since we must admit from the evidence assembled by comparative neurologists that there has been a progressive evolution of the nervous system, we must further assume that psychic side of nervous activity has likewise become more complex. The evidence at hand indicates that in the relatively simple nervous system of the shark the responses to sensory stimuli occur with a minimum of complexities and delays, whereas in the highly complex brain of the higher mammals the neopallium or new brain forms a most elaborate detour which is imposed on top of and between the more direct pathways of the primitive vertebrate brain. Such is the speed of nerve currents, however, that the slight delay in response is far overshadowed in importance by the superior initial advantages of the new method. For no matter what may be the physical basis of memory, it is at least certain that mammals have a peculiarly good memory for whatever classes of events happen to be of interest to them.

Thus each new stimulus, giving rise to a specific desire for action of some sort, is confronted with the memories of what happened the last time when a similar impulse was not restrained. The animal soon remembers the best way to respond so as to attain his immediate objective. Thus we have the basis of learning, that is, of progressively improved adjustments to familiar situations.

(Continued on Page 6)

The Confusion Of Tongues

By OSCAR RIDDLE

Carnegie Institution of Washington, Station for Experimental Evolution, Cold Spring Harbor.

DURING the past fifteen years several states have passed laws which prohibit the teaching of evolution in their public schools. This prohibition, and a strong sentiment of similar nature elsewhere, implies several most serious things. We know the importance of the textbook, and we may first note that this sentiment has written itself into some text-books widely used in both high school and college. These books put not emphasis but a wet blanket on one or all aspects of the evolution principle; and they often succeed in leaving only a pale ghost of our science in the student's hands. I submit as evidence some excerpts from an elementary textbook published in 1934 and already introduced into more than 131 normal schools and colleges in at least thirty-seven of our states and territories. A chapter of this book is entitled: "The process of evolution cannot yet be satisfactorily explained." The final section of this chapter is dedicated solely to the proposition that what it calls "the doctrine of evolution is quite compatible with a religious faith." Of course to the untrained pupil this can only mean that it is quite compatible with whatever view of religion, or of the supernatural, he or she happens to have at the moment. I quote from four paragraphs the following illuminating lines:

Dr. OSCAR RIDDLE

"The reader should remember that even Darwin himself did not believe acceptance of the evolutionary idea to be incompatible with a religious faith . . . Why should the full blown rose, the birds in the trees, the beasts in the field and the stately oaks standing in the forest not be considered as much a part of God's world as the subjects of which the Bible treats?" There follow four lines from the Psalmist, and then this: "If this conception of the universe were kept in mind it would obviate much strife and confusion. The scientist can make no distinction between the natural and the so-called supernatural. What man can study, experience, and learn about through his senses is the natural; the supernatural is that part of the universe which he has not yet been able to understand (*sic*) or for which his powers of comprehension are too limited. There is no difference between the two. The difference comes only in man himself. . . . So, then, since evolution neither denies the existence of God nor disclaims His directive influence over natural processes, it cannot be said," etc., etc. Then, "Finally, it must be remembered that the theory of evolution does not attempt to say when, why, or by whom life was first produced upon the earth. The honest scientist when pressed for an answer will say that he does not know."

Why any text-book whose purpose is to outline and guide in the study of life-science should contain a single word on the subject discussed at such length in this book is beyond comprehension. Your zoologist who loves, teaches and builds his science very well knows that his task is to facilitate an advantageous encounter between the student and the useful and vitally significant phenomena and principles of biology. As a true scientist he will not rob his teaching of that special and incomparable discipline which only the sciences can give—his student will have to wrestle with the facts and principles he finds. If, and when, astonishment at the inclusion of such material in a text-book is sufficiently overcome, the biologist who knows that his science to-day is not where Darwin left it will swear that he had not believed it possible—outside of theological discussions—to find words for a few extraneous paragraphs that would so defraud our science.

If one could subtract the emasculated biology taught from such texts in 1935 from the total for 1935, how would the amount of zoology taught now compare with that in 1905? Some of the zoological text-books of thirty years ago may have been dry; but they were not rotten.

Our effort is to learn why biological science has not obtained and maintained its proper place in our schools, and why great biologic truth is so little possessed by our people. We have yet to search the motivation of those several instances of state laws which prohibit the teaching of evolution. It was traditional religion that thus invoked the heavy hand of legislation. Elsewhere, without invoking the law but with its extended and varied influence, traditional religion is now effecting a wide-spread repression of the teaching of this central principle of biology in our public schools. It sometimes forces the resignation of able zoologists even from college positions; and in high schools and late primary grades there are probably to-day few places where straightforward teaching of the unmitigated evolution principle can be done except at the peril of the teacher. An eviscerated straw-man is set up in place of the reality for the younger students of denominational and parochial schools everywhere. Many millions of our present and future citizens are robbed of a biological outlook, or they get one that is warped and unrecognizable, through direct responsibility of the church.

Biologists in nearly all countries, and particularly in our own, have tried a compromise with religious creeds. That compromise has failed. Most youth of 1935, like those of 1859, leave our schools without having opportunity to learn that the worthy facts concerning man's origin and destiny come not from religious traditions but from biological investigations made within the time of men now living. That compromise now robs most modern youth of opportunity to learn what is known concerning his or her place in nature. In what is said here I am not concerned with the question whether religion is important; nor whether one or another of the creeds of the earth has

From The Teaching Biologist. V: 2, Nov. 1935

or has not sufficiently "adjusted" its teachings to modern knowledge; nor whether one or another of them is good, bad or quite indifferent. But whatever the answer to those questions the present restrictive influence of organized religion on the teaching of the best of biology is intolerable. For moribund traditional beliefs to continue to exercise such influence over the educational program of a country is a confession and declaration either of the apathy, the cowardice, the impotence or the intellectual bankruptcy of enlightened leadership in that country.

It is here that we meet "the confusion of tongues." A hundred years of a germ of truth, or seventy-six years since its bloom in publication, has catalyzed a very wide-ranging body of facts relating worthily to the nature, origin and destiny of man. However, by many this prime accomplishment of our science is either rejected outright, or its essentials are first thoroughly eviscerated and the husks then accorded an obscure corner in the attics of tradition. The tongues of the traditionalists are heard not merely from pulpits, but they echo also within our schools—the only possible home of science—and there they now curb or tie the tongues of biologic truth.

This confusion is partly sustained by the words of great authorities in one or another branch of learning. Today, as at Oxford in 1860, a professor can easily be had to support a bishop against a really good and far-reaching biological advance, where this impinges on traditional beliefs. The public can not fix relative values to the words of different scientific men. But the biologist knows that when physicists and astronomers speak about life, they speak as laymen—and frequently their words are unconsciously filled with tradition, which they also acquired as laymen. In addition to these volunteer voices from quite outside life-science, we are all aware that some high authorities in biological science persistently ignore the greater biologic accomplishment, and on some points they too still speak with tongues of a day that is gone. We may as well have it out with them.

In conclusion, no one need espouse intellectual sterility because many and important mysteries still attach to the living world. The task of serious biological analysis—the thrust of observation and experiment against assumption and tradition—was begun only yesterday; and, very unfortunately and quite inexcusably, it is not until an unseen to-morrow that even 1 per cent of mankind will become conscious of as much as 10 per cent. of the quite important mysteries which a sharp attack has already swept away. The issue to-day is on the question whether our educational facilities and practice will permit eager youth to examine the results of man's scientific efforts to learn man's own nature and man's place in nature; whether ignorance of many fundamental and now satisfactorily appraised biological phenomena shall continue to foster divergent and irreconcilable thought among great biological human populations which must live together; whether the case and the course of civilization is to be guided by knowledge or by the dead hands of the past; whether the biological investigator of either yesterday or today may be permitted to give his best results to the world or whether he is to be more and more insulated by his own progress; whether, indeed, present man-in-the-mass has evolved sufficiently to prefer light to twilight, truth to tradition. Certainly until this issue has been definitely decided every zoologist will feel sure that mankind is worthy of much more than his very best efforts; he, along with all other enlightened men, must find, recognize and overcome those forces which now obstruct the release of his best prizes to present generations of man.

Excerpt, vice presidential address, Section Zoological Sciences, A.A.A.S., St. Louis, Jan. 1, '36. Printed in Science, 83: 41 & 69, Jan. 17 & 24, 1936.

CORRECTION

The credit lines on pages 3 and 5 got mixed. Dr. Gregory's article is from The Teaching Biologist, Dr. Riddle's from Science. My own fault. L.E.K.

NATURE'S UPSTART: HOMO SAPIENS

Continued from Page 4

Up to the time that the ancestors of man began to become human, the newer type of response may have been almost as uniformly beneficial and successful as it seems to be in other mammals. But at this point the devil appears in the story to wreak havoc on the happiness of simple humans. This devil is nothing more nor less than the habit of unintelligent and uncritical yielding to suggestion, that is, to arbitrary association of ideas. The "conditional response" of Pavlow on a lower plane foreshadows the vast brood of taboos, phobias, blessings and curses and all the practices of magic and superstition on the plane of social relations. For example, among many primitive peoples, sickness is not the result of some purely physical or physiological disturbance but is sent by the gods as a penalty for the violation of taboos, perhaps by another member of the family. The way to cure the sickness, therefore, is to pay a witch-doctor to find the culprit whose sin has brought the sickness and punish the culprit.

The invention of speech, in which a given sound or a series of sounds is arbitrarily associated with a certain idea, led to verbalized thinking and enormously facilitated the establishment of habits of reaction based on fictitious taboos and rewards. As a result of this situation the progress of humanity in discovering the causes of disease and curing it was delayed for ages and is still delayed among the less intelligent of all lands.

Another factor which has contributed greatly to the bedevilment of *Homo sapiens* is his almost incurable pride and egocentrism joined to a pathetic gullibility. Egocentrism and selfishness are natural in the descendant of a long line of vertebrates which are designed by nature to pluck or kill and eat without any regard to property rights. The gullibility follows from the easily imposed habit of acting in masses under the suggestion of leaders. Also the tendency to believe the oft-repeated printed word.

In short it seems that a large part of the agony of mankind could have been spared if man had been at the same time less egocentric and less credulous.

The Emancipation of Homo Sapiens

In spite of man's tragic subservience to mass manipulation, one must admit that during historic times there has been definite improvement in some individuals and in some communities and even in a few states. The main hope for *Homo sapiens* seems to lie in the principle enunciated by Lincoln, namely, "that you can fool some of the people all the time and all of the people some of the time but you can not fool all the people all the time". It is the tough-minded residue, as well as those who can learn by experience, who slowly sift the wheat from the chaff, hold fast to that which is good and press forward steadily to a more rational world; there justice and gentleness shall ameliorate the hard fact that *Homo sapiens* is the descendant of a long line of aggressive vertebrates.

An Evolutionary Time Scale

By A. M. WOODBURY

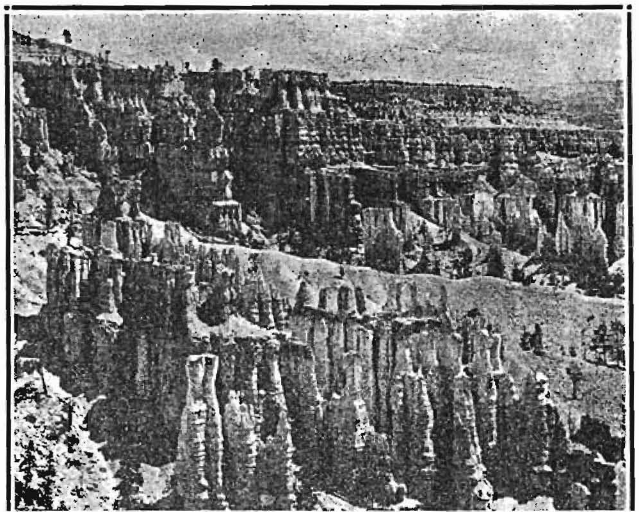
Professor of Biology, University of Utah

THE ordinary visitor to Zion and Bryce Canyons of southern Utah and to the Grand Canyon of Arizona little realizes the wealth of scientific information to be found in the geological history of the region and its significance in the interpretation of evolution. The time scale in evolution depends for its interpretation largely upon the relative positions of the different rock layers of the earth. Here, the sedimentary rock layers, spread out in horizontal fashion one above the other, produce a total depth of about three miles. These layers have been relatively but little disturbed so that they clearly show their relationships to one another.

The edges of these rock layers are so exposed to view that they can be traced readily. The bottom-most mile of these rock layers is exposed in the Grand Canyon (Evolution Vol. 3, No. 4. p. 10, May, 1932). The second mile of such layers may be found exposed between the brink of the Grand Canyon and the top of Zion Canyon. The third mile extends up the face of the higher plateaus to the top of Bryce Canyon (See Chart).

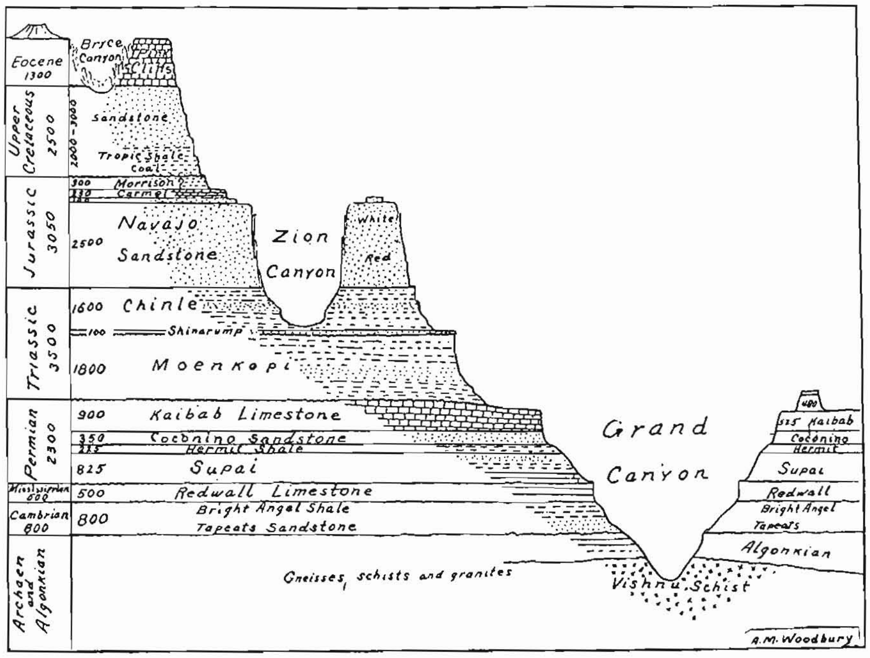
The extremely old rocks exposed in the bottom of the Grand Canyon are the foundation upon which the horizontal stratified sedimentary layers rest. It is obvious that the lower rocks must have been in position before the succeeding layers could have been deposited on top. These sedimentary layers deposited through the action of wind or water thus show a successive series in time, the older layers below and the younger ones above. This does not imply it to be a continuous series. A layer once deposited, may have been exposed to erosion and part of it worn away before the next layer covered it. Such lapses of time are referred to as unconformities and there are at least ten major and many minor ones in these three miles of rocks. Some of them represent lapses of time long enough for whole mountain ranges to be worn down and planed off by erosion.

The Permian rocks (Kaibab limestone) at the top of the Grand Canyon are covered by the Triassic rocks 3500 feet thick in the region below Zion Canyon. These are covered by the Jurassic rocks 3050 feet thick in the Zion Region. These rocks are in turn buried by those of the Upper Cretaceous, 2000 to 3000 feet thick, which reach up to the bottom of Bryce Canyon. The topmost layer, which is of Eocene age and buries all the others, is a non-marine water-deposited limestone about 1300 feet thick known as the Pink Cliffs. This is the layer in which the indescribably esthetic carvings of Bryce Canyon are cut.



Courtesy United States Department of the Interior
BRYCE CANYON
Compare with Zion Canyon, pictured on our front page

The fossils of algae, primitive as well as higher invertebrates, fishes and the fossil footprints of amphibians found in the Grand Canyon are older and more primitive than fossils found higher up in the series. Fossil remains or footprints are found in the layers of the late Triassic or Jurassic rocks. The writer has taken fossil petrified trees from the early Triassic, ganoid fishes from the later Triassic and has seen many reptile tracks in rocks of the same age. Near Kanab in southern Utah, on top of a projecting ledge where the softer shale from above had worn away, a series of dinosaur tracks were exposed to view. They were as plain and unmistakable as the cow's



DIAGRAMMATIC PROFILE

Columnar Section showing stratigraphic relations of Bryce, Zion and Grand Canyons

footprints which the cowboys follow on the range today. The dinosaurs of a half-billion years ago left their tracks on the muddy bottom lands. The next flood covered them with mud and thus preserved them in the rocks through the long intervening ages. At one point, the tracks of three different animals were found crossing each other—we called it "Dinosaur Junction."

Other fossils have been found in the higher layers, but the record in that region stops at the Eocene in the beginning of Cenozoic (late life) time. Since the Pink Cliff limestone was laid down, the entire region has been uplifted from near sea-level to its present elevation. During the period of uplift, streams of water have been at work wearing away this sedimentary material, cutting washes, gorges and canyons, and leaving the edges of the layers exposed to view. The Colorado River has cut deepest, having reached the bottom of this three-miles of sedimentary material. Even though there is only a mile or more of the material left at the Grand Canyon to show, it is believed that a good deal of the upper material once extended over it and was stripped away before the canyon as we know it now was carved.

Zion Canyon, cut by the Virgin River, a tributary of the Colorado, is three-fourths of a mile deep at its mouth. But this is only a small part of the stream's work, for it is practically certain that much of the upper mile of rock layers formerly extended over Zion Canyon and was removed by the processes of erosion before the present canyon came into being. Bryce Canyon has been cut about 1300 feet deep through the topmost layer by means of temporary streams produced by storms without the aid of a permanent stream of water.

The time scale revealed by the region, although not complete, indicates a tremendous period for the history of the earth. There are three phases which must be taken into consideration: 1st, time enough for the accumulation of sediments to a depth of three miles (15,000 to 16,000 feet) by the natural processes of sedimentation, involving all of the principal types of deposit, limestone, shale, sandstone, and conglomerate; 2nd, the lost periods of time that elapsed during the unconformities; and 3rd, time enough to carve the present canyons and wear down through the three mile series.

When viewed in the light of recent calculations of earth age by the use of radium, there is little doubt that the history of this southern Utah - northern Arizona region must be read in terms of hundreds of millions, perhaps billions, of years—time enough for the development of the evolutionary changes in living things that biologists recognize to have occurred.

Mammoths and Mastodons

By ALLAN BROMS

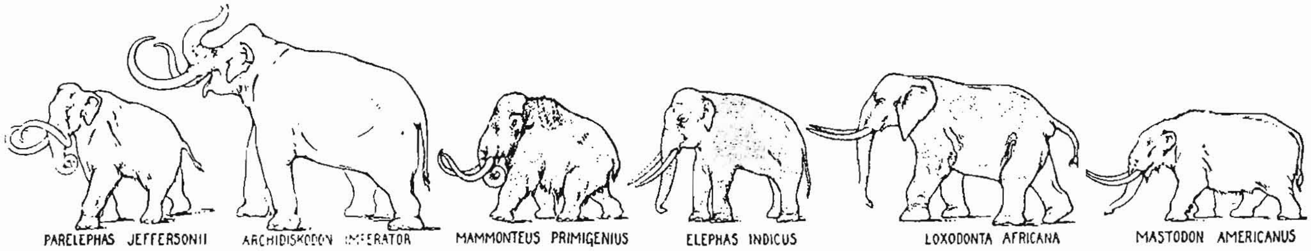
EVERYONE knows that mammoths and mastodons are some sorts of elephants, now extinct, and probably thinks them of enormous size, much bigger than living elephants, though this is not true. The name "mammoth" is assumed to have been given because the animal was of mammoth size, but the truth is just the other way round, we call things mammoth after this animal. Actually, the name comes from the Tartar word "mamantu" meaning ground-dweller, for the Siberian peasants found bones and even flesh, but no living animals, and so concluded that these must be giant moles who dug their way underground with their ivory tusks, but promptly died when they accidentally saw the sunlight. So this name was modified and adopted for scientific use. The name "mastodon" means "nipple-toothed", describing its distinctive teeth. Mammoths and mastodons are very different, the mammoth being a true elephant, with elephant teeth, while the mastodon is just a cousin. You can always tell them apart by looking in their mouths. A mastodon tooth looks like a mountain range of serrated peaks, while a mammoth tooth has a flattened surface crossed by narrow ridges of hard enamel which stand out from the softer cement and dentine which wear away faster in use, the surface being thus kept rough for grinding. Besides, a mastodon tooth has several roots, a mammoth tooth but one.

Also, had you seen them in the flesh, you could easily have told them apart. The mammoth was short, tall at the shoulders, low at the hips, his back sloping sharply rearwards. Besides he was narrow when you got a front view. The mastodon was of longer build, not tall either fore or aft, but very wide and broad-backed.

We know just how they looked because we have fine fossil records of them, not only bones, but flesh and hide and hair, and let's not forget, pictures drawn by primitive man who hunted and was hunted by them. But there are no live mammoths or mastodons, nor have there been for thousands of years. A hundred years ago, it was quite reasonable for President Jefferson, himself a scientist, to look for the finding of live mastodons in the then unexplored Northwest, for the fossil bones looked very fresh, but now that we have explored and not found them, the question is settled, there are no living mammoths or mastodons. But we must discuss them separately, for the mastodon lived last in North America, while the mammoth lived in Asia and Europe too.

The first mastodon bones were found near Albany, N. Y. in 1705. A few years later Cotton Mather wrote that they were the bones of a giant, quoting that "there were giants on the earth in those days". In Europe too, the first remains of mammoths and mastodons were hailed as of giants and of saints, a more reasonable theory being that they were Hannibal's elephants used in invading Rome. The next mastodon finds also came from New York, for in both 1799 and 1802, C. W. Peale found fairly complete skeletons. Soon they came thick and fast, from other states as well, one deposit just south of St. Louis yielding hundreds of individuals. Then in 1845, just fifty miles north of New York City, six miles west of Newburgh, the practically complete Warren skeleton was found with the bones in place just as the mastodon had mired itself in a swamp. It was carefully removed, the parts wired together and then exhibited, first as a travelling show, then in a small Boston museum and now finally, after correct remounting, at the American Museum of Natural History. Miring in swamps and quick sands seems to have been a common death for mastodons. At least that is how most of them are preserved to us.

The mammoth lived here too, but the best fossils are



from Siberia and Alaska, for there they are found frozen into ice that has not melted for thousands of years. In these natural refrigerators they have been kept quite intact, so fresh that dogs eat their flesh. We know that they had a heavy covering of hair and wool fitting them to survive through the long, intense cold of the Ice Age. So we call this species the Wooly Mammoth to distinguish it from others of even larger size that roamed farther south here in North America, namely the Jeffersonian Mammoth and the Imperial Elephant, giant of them all. The mastodon also had a hairy covering, for a golden brown sample has been found. The Wooly Mammoth however stuck closer to the cold edge of the melting ice sheet and northern Siberia is today full of fossil ivory, so full that regular prices are quoted on it in the markets of the world. One of the refrigerated carcasses was found in 1799 in the ice along the Lena River and what remains after the dogs got done with it, is mounted in the museum at Leningrad. Another, found in 1900 at Beresovka, Siberia, was largely saved. It had fallen into a deep pit or crevasse, probably during a blinding blizzard, had broken several bones, and being too crippled to struggle out, had died in the position of climbing. Even the contents of the stomach were preserved, showing that it lived on grasses and birch leaves.

There are many guesses why the mammoth and mastodon, despite their numbers, became extinct. Their intelligence and strength should have saved them. One recent guess (you can guess the source) held that they were too big to get into Noah's Ark and so were drowned. Another is that since elephant skins lack oil glands, moisture could freeze in the hair of the Wooly Mammoth and Mastodon, killing them off. But they survived through the Ice Age and died when the weather became warm. Also, their southern relatives, the Jeffersonian Mammoth and the Imperial Elephant, died out. Maybe some contagious disease wiped out the tribe, we do not really know.

But though we do not know why they disappeared, we do know something about how they began, for fossil remains have been found of their ancestors, mostly in Asia and Africa. They started in Egypt with the little Moeritherium about two feet tall who lived some tens of millions of years ago in the Eocene Epoch along the River Nile, spending much of his time in it. He had quite an ordinary mouth, without trunk, but with two upper and two lower tusks or long canine teeth. The nearest living relative is the Sea Cow or Manatee. From the very ordinary Moeritherium evolved many strange mastodons and elephants. All had the rooting habit, like our pigs who also develop tusks in their wild state. At first both the lower and upper jaws and tusks grew longer. Then there had to be some way of reaching beyond them for getting food back to where the mouth was. So the nose and upper lip extended into a long flexible tube with a sensitive and very deft tip to feel and handle things with. Slowly through the millions of years this evolution went on, the tusks and jaws and trunk getting longer. In several the lower tusks become spoon-shaped or spade-shaped for digging and scooping. Walter Granger recently showed me one such spade from Mongolia fully a foot wide. A spoon from Nebraska was four feet long. But other species began to lose their long lower jaws and tusks, among them Stegodon, whose teeth are a compromise between those of mammoths and mastodons. Occasionally old mastodon bulls hark back to such four-tusked ancestors by showing tusk remnants in their lower jaws.

With long, heavy upper tusks and trunk, the recent elephants had to have strong, short necks, so the skull changed in shape and bracing to give better leverage. To uphold the ponderous beast itself, the legs became massive pillars, set straight up and down for solidity, supported by compact, tough, padded feet. For centuries the ancients debated whether an elephant had leg joints, he stood so sturdily stiff-legged. With powerful limbs, an overwhelming might, and an ever urging wanderlust, which may be just the curiosity of intelligence, he traveled the world over, invaded new conditions, which made him over to fit them by natural selection, and then generation by generation died to leave the fossil record by which we now decipher his story.

PRESSURE FROM THE PULPIT

Recently a quotation from Hendrik Willem VanLoon's "Story of Mankind," written on a blackboard in Beech Grove school, Indianapolis, sent Rev. Verdi Allen, Baptist preacher, on a rampage with the war cry: "Our people don't want pupils taught the Darwinian theory but the Genesis record."

Principal Mann is reported to have side-stepped him neatly with "Mere citing of the opinion of others does not imply belief in them." While State Superintendent Murray pussyfooted as follows: "The theory of evolution should not be advocated, and frankly I doubt if it is advocated in any school in Indiana." No comment needed.

Help us to offset this pressure from the pulpit by sending EVOLUTION to every public and school library in Indiana that will accept it. Five hundred dollars will do it. Send a check to help Enlighten Indiana.

SYMPOSIUM ON EARLY MAN

AN INTERNATIONAL SYMPOSIUM on Early Man was held March 17th to 20th under the auspices of the Philadelphia Academy of Science. Many world-renowned anthropologists, archeologists, geologists and anatomists contributed to a summation of present knowledge regarding ancient man. We hope to present some of this interesting material to our readers in an early issue.

Of course, in such a gathering of scientists the *fact* of evolution is taken for granted, and the fundamentalist viewpoint of special creation is no longer considered, or even mentioned. Does this mean anything to our fundamentalist friends and the school boards that they control?

A Lesson In Variation

By RALPH C. BENEDICT

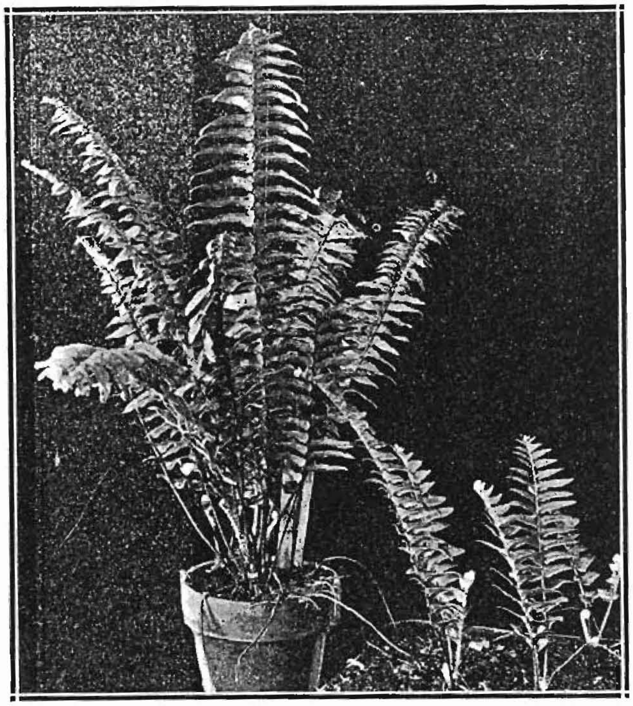
Professor of Botany, Brooklyn College

THIS article outlines a possible laboratory lesson through which the most fundamental factor of evolution may be presented objectively. It has been used a number of years in fourth year high school biology. The facts of morphological resemblances among related forms, geographic distribution, geologic succession of types, embryological and ontogenetic development, plant breeding, etc., are valuable and important as circumstantial evidence, but an understanding of the basic problem of evolution must be sought in a study of *variation* as a *process*.

If occasionally in reproduction parents produce offspring which differ from the parent type, and not merely by the re-shuffling of characteristics already possessed by collateral forms, we are brought face to face with the elemental fact upon which any real understanding of evolution must be based.

Variation is one of the numerous words which have a number of different meanings. The word is not used here in the common interpretation as referring to the range of differences between the individuals of a larger species population. The meaning can be sharply delimited to the desired application by the question: Will evolution take place if offspring always repeat the exact characteristics of their parents? Why must variation occur as a process in reproduction if new forms are to evolve?

Is there any evidence of such variation? The Boston fern series furnish excellent material for class study. They are relatively common, and easy to obtain. The range of variation between the different varieties is wide, the differences well marked, and the material is large enough so that the difference can be seen easily. The method of reproduction is entirely vegetative, thus eliminating the possibility of complication through hybridization.



Courtesy Brooklyn Botanic Garden.

FIGURE 1. Vegetable reproduction of Wild Sword Fern. The three bud plants are all like the parent. In variation one or more would be different.

The mode by which variation must have taken place in these fern types can be pointed out easily, and is illustrated in figure 1. This shows a parent plant of the wild sword fern from which the Boston fern was derived, in association with three offspring which have arisen along a lateral stolon. Such stolons are common in Boston fern varieties, and the methods of vegetative propagation along stolons can usually be demonstrated by digging up a little surface dirt around a well-established pot plant.

While in general the offspring are practically identical with their parent, a number of times, in the florists' cultivation of millions of Boston fern plants, an occasional bud plant has arisen which, while still in physical connection with its parent plant, has shown distinct differences from the parent. Figure 2 shows the leaves of a typical Boston fern together with seven such departures or variations. Beginning with the first plant, each of these variations reproduced only its own type, maintaining the difference from the parent Boston fern, and thus representing that kind of variation which is inherited, or *mutation*.

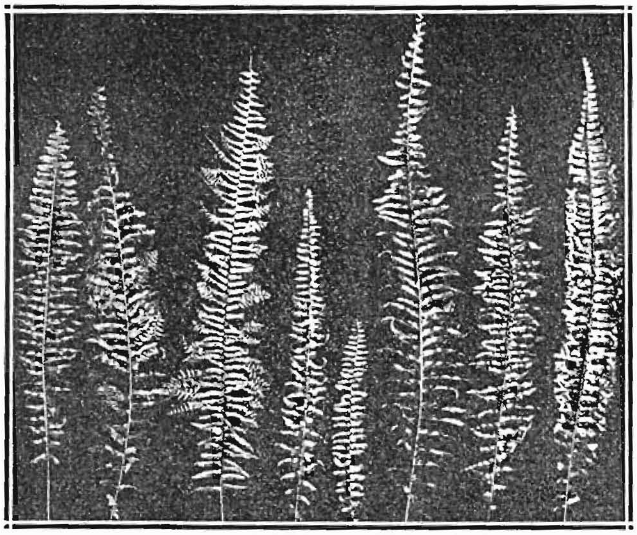


FIGURE 2. Leaf of Boston Fern (left) with leaves of the seven primary sports. In each case, the original mutation took place in vegetative reproduction (see Fig. 1)

This does not establish what the process of variation is; it merely makes obvious the fact of its occurrence, and it is evident also, that whatever happened must have taken place somewhere along the stolon or reproductive branch from which the different buds arose.

The third figure, showing representative pinnae of the same leaves shown in figure 2, makes clearer just what types of differences have resulted from the variation process in the Boston fern. These differences parallel to some extent the characteristics which distinguish recognized fern species. When, in addition, consideration is given to the extreme modifications developed through secondary and further variation in this same group of ferns, resulting in scores and scores of well distinguished varieties, a new understanding should attach to the meaning of variation as a process and its underlying significance in evolution.

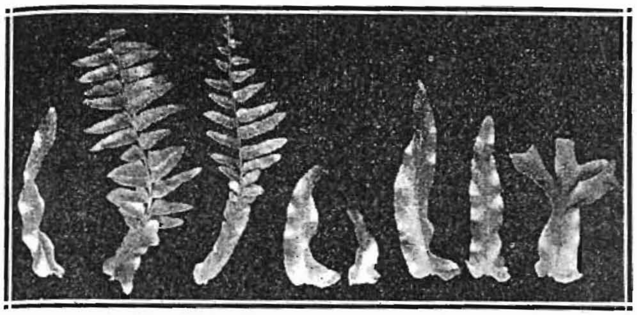


FIGURE 3. Pinnae of Boston Fern and seven primary mutations, arranged as in Figure 2.

Dozens of new forms have appeared in the Brooklyn Botanic Garden during the years of experimental culture. Four kinds of variation are represented among these primary sports of the Boston fern. (1) increase in division, from once to twice pinnate, (2) dwarfing; (3) increase in ruffling; and (4) cresting.

The second and third leaves represent increased leaf division. The third leaf is from the "Anna Foster" variety, the earliest of all the Boston fern sports. The "Pierson" fern is shown in the second leaf and pinnae. From this form alone, scores of secondary, tertiary and higher degree sports have developed, resulting in various degrees of leaf division—up to five pinnate,—and other modifications.

The fourth and fifth leaves and pinnae represent dwarf types, "Scott's" fern (of Brooklyn origin) and the Giatras fern. In addition to their smaller size, each offers other differences in outline, marginal characters, and configuration of the pinnae, and in the habit of growth.

The sixth and seventh leaves and pinnae present intensification of the ruffling or waving of the pinnae, horticulturally known as *crisping*. The larger leaf (6) is called the "Harris" fern; the other the "Roosevelt". Lastly, there is a *crested* or "fishtail" type of variation, which occurs not infrequently in wild native species. In the Boston fern series this variety first appeared in Louisiana, and takes its name from the town of its origin, "Gretna".

That evolution must have occurred by means of inherited variations will be accepted as axiomatic. The student who has examined material of the kinds presented here will form a clearer conception of what is meant by variation, and a better understanding of the relation of this process to evolution.

From Torreya 30: 145-152. Brooklyn Botanic Garden

Evolution Remains Darwinian

By HENSHAW WARD

Has the Darwinian Theory of Natural Selection been discarded by scientific men as fundamentalists so often profess to believe? Do the latest facts disprove the evolutionary theory? Dr. Ward answers by quoting the opinions of modern scientific authorities.

A recent editorial in the New York *Times* entitled "Darwin Fifty Years After," contained these two sentences: "Research conducted within the last decade has shown that almost imperceptible mutations are the ones that count in evolution, and that by selection their direction and preservation are determined. So we come back to Darwin's own Darwinism." The *Times* is not an authority on biology, but it indicates the trend of recent conservative thought. Its editorial is proof that the greatest hindrance to popular acceptance of Darwinism is disappearing.

That hindrance was the doubt which some biologists felt about Natural Selection. The doubters (mostly students of genetics) were wont to express themselves thus: "Though we have no doubt of evolution, we suspect that Darwin's theory may not be the right explanation." The suspicion was interpreted by many literary and philosophical minds to mean. "Darwinism is in a bad way."

Even if Darwinism had died, the evolution theory would not have been disturbed. But the theory can be much more readily accepted by the general public, and can do its work in education more smoothly, if it does not have to encounter the perpetual query, "But isn't Darwinism disputed?" During the last few years so many authorities have spoken so strongly in support of Darwinism that even the *Times* is persuaded.

The most important element of Darwinism is Natural Selection—the theory that in the hard struggle for existence the favorable variations are preserved in heredity, and that there is thus a gradual alteration in a species which adapts it better for successful living. A less important element of Darwinism, but one that has loomed large and has seemed vital to many reasoners, is the theory that the principal material of evolution has been the small variations. Critics of Darwin have been dubious about the power of Natural Selection, and they have assumed that Darwin's small variations have been supplanted by the large sporting mutations such as de Vries described.

The following quotations indicate how general and thoroughgoing is the sweep of recent biological thought toward Natural Selection and toward the conviction that no modern investigation of "mutations" has furnished any substitute for Darwin's conception of inheritable variations, whether small or large.

1. Prof. H. J. Muller is the most natural man to quote first:—"Data on the actual occurrence of mutations support Darwin." He knows. His investigations of mutations by X-rays are so highy respected that he was chosen by the *Britannica* to write the article "Variation". In that article he declares: "Geneticists are returning to a view essentially similar to Charles Darwin's— namely, that the origin of one species from another involves the accumulation of numerous selected small steps of heritable variation." Since it was the geneticists who used to raise most doubt about Darwin's conception of variation, there is

special significance in this judgement of a scholar who is in the van of recent genetics.

2. The *Britannica* also secured an entirely new article on evolution, written by Professor Goodrich of Oxford. He argues that "the case against Darwin" has not been established. He speaks of "the process of natural selection whereby adaptation is brought about"—which is a more sweeping claim than Darwin made. He says that no hard-and-fast line can be drawn between "sports" (i.e. large mutations) and small variations. He specifically denies that De Vries distinction between mutations and small variations is valid.

3. The chief concern of H. G. Wells and his advisers when they wrote the *Science of Life* was to expound the views that are considered safest by the specialists. Here is their decision about Natural Selection: "The broad propositions of Darwin reemerge from a scrutiny of the most exacting sort essentially unchanged . . . What has three quarters of a century done to modify Darwin's view? Our answer is 'Practically nothing'."

4. J. B. S. Haldane is a Cambridge geneticist whose opinion on any subject in his field carries weight. He testifies: "No satisfactory cause of evolution other than the action of natural selection has ever been put forward . . . . No facts definitely irreconcilable with Darwinism have been discovered in the sixty years and more that have elapsed since the formulation of Darwin's view . . . Darwin's ideas still hold the field today."

5. Sir J. Arthur Thomson, the veteran maker of a long list of dependable books on biological subjects, is always most careful to present both sides of a case. Yet he is not ambiguous about Natural Selection: "What has happened during the domestication of animals and the cultivation of plants is closely parallel to what has happened in Wild Nature in the evolution of new species." (*Riddles of Science*) This is a neat summary of Darwin's entire argument, and a complete endorsement of it.

6. In *The Coming and Evolution of Life,* Professor Crampton of Barnard College thus expresses his judgment: "All of the discoveries up to the present time have thus corroborated the essential tenets of Darwin's formula of the dynamics of evolution—i.e., the natural selection of congenital characteristics."

7. Professor L. L. Woodruff in his *Animal Biology,* says of Darwinism: "The consensus of opinion is that natural selection in general is the guiding principle underlying the establishment of the adaptive complexes of organisms . . . . So this is essentially a clarified Darwinism . . . . Natural selection still affords the only explanation of that co-ordinated adaptation which pervades every form of life."

8. Many an intellectual has expressed his distrust of Darwinism in the *New Republic* during the past decade. Therefore Julian Huxley's verdict in favor of Darwinism had special point when it was published in the *New Republic*: "Whereas at first only large mutations, producing striking effects, were known, intensive study has revealed that small mutations are more numerous, and also more important as raw material for evolution . . . Selection is the main agent which directs and guides that change. . . . Observation and analytic studies of genetics can all be reconciled in the fundamentally Darwinian idea of gradual change, due to the accumulation of small Mendelian mutations under the influence of natural selection."

Julian Huxley's finding is that "We can all be Darwinian again." So we can. There is no longer any need to be troubled by the factional disagreements of the specialists. Evolution remains Darwinian.

Amateur Science

ROBIN THE THRUSH

By Pauline Dederer

One sure sign of Spring is the Robin returning from his southern wintering, finding plentiful Spring food in the worms and seeds of man's lawns. His red breast is sufficiently distinctive to identify him to everyone, but is very misleading as to his relationships. He really belongs to the Thrush family and we all know *they* have *spotted* breasts. Nevertheless, the Robin is a Thrush, spots or no spots. He may hide it from himself, but his youngsters give him away. Watch them as they hatch and grow up. Look carefully at their breasts. They do have spots on their breasts, a bit faint perhaps, but still spots, just like any other Thrush. Very probably, the common ancestor of the Robin and his relatives was just a spotted Thrush. The Robin, as it evolved, lost those spots, but its youngsters, by way of summing up the ancestral history in their individual lives, go through that old Thrush stage before assuming the recently acquired red breast. Incidentally, the common Bluebird (not the Blue Jay, who belongs with the Crows) is also a Thrush, only in his case the secret is fairly safe; his youngsters do not give him away, they have no breast spots. But that absence of spots does not mean a thing, they are still Thrushes, as we know from other resemblances, only they have gotten over their ancestry more thoroughly than the Robin young.

Question Box

FILTERABLE VIRUSES

By Lucy Orenstein

Q. What is meant by a "filterable virus"? I have heard this term used in connection with certain diseases like hydrophobia and measles. —*A Reader.*

A. Filterable Viruses are among the most provoking of organisms because of their elusiveness. They are ultra-microscopic, that is, they cannot be seen even under our most powerful microscopes. They are also filterable, that is, they pass right through our finest filters made of porcelain or special earth. Such filters will trap bacteria and protozoa but cannot catch these viruses. Any knowledge that we have of the filterable viruses is knowledge of their activities in certain diseases, rather than of their structure or appearance.

It is even questioned whether these tiny particles are living organisms, although they are generally accepted as such. All our knowledge concerning them is very recent. The latest investigations suggest the possibility that filterable viruses may be the border-line between the non-living and living worlds.

Not only human diseases are caused by filterable viruses. A disease of tobacco known as leaf mosaic disease has been studied widely by scientists interested in filterable virus. Foot and mouth disease in cattle, psittacosis, the rabbit disease which received so much attention lately because it is communicable to man, are other examples. Among the human diseases believed to be caused by filterable virus are measles, smallpox, influenza, hydrophobia or rabies, and common colds.

The interest in the subject of filterable virus is a two-fold one. There is its relation to disease, which alone would tempt scientists to pursue the subject. There is also the possibility that an understanding of these elusive substances or organisms may bring us closer to an understanding of the very nature of life itself. It may be that the key to life's origin lies right here!

Early Views On Fossils

By F. M. CARPENTER

Department of Paleontology, Harvard University

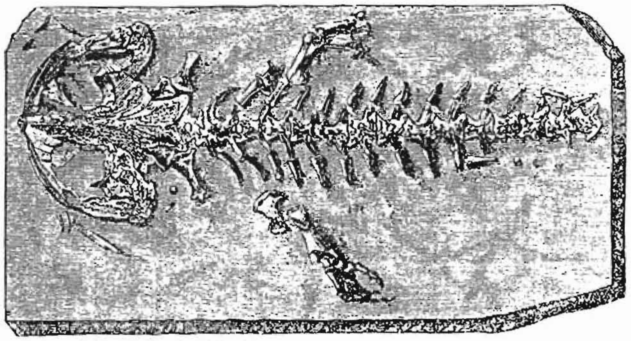
Fossils have probably been the cause of more curious speculation than any other earthly objects. Fossil shells, crinoids, plants, and even bones are common in most parts of the world and did not escape the notice of the ancient philosophers and writers. The Egyptians apparently had no idea of their nature, although they used petrified logs for the foundations of desert roads. The ancient Greeks, however, correctly recognized them as the remains of once-living organisms. Xenophanes (6th century B.C.) stated that sea shells high up in the hills of Malta indicated that the hills had been periodically submerged under the sea. Other Greek writers, such as Xanthus, Pythagorus, and Herodotus, also accepted this explanation of the origin of the remains of marine shells in inland regions. Theophrastus (300 B.C.), however, believed that fossil bones were produced by a plastic force in the earth. During the early middle ages this view was the accepted one, the correct idea of Xenophanes and his followers being abandoned. This was largely due to the influence of the Christian Church. If anyone who observed sea shells imbedded in rocks forming a mountain range ventured to express his belief that the mountains consisted of materials accumulated under the sea after living creatures appeared on the earth, he was in danger of being punished for heresy; for according to the Holy Writ, land and sea were separated on the 3rd day of creation, but life did not begin until the 5th day. Also, the obvious conclusion from the evidence of fossils that the material forming the rocks must have accumulated over many thousands of years was contrary to the received interpretation of the amount of time which had passed since creation. It is not surprising, therefore, that the favorite mode of avoiding the difficulty was simply to deny that the fossils were remains of living creatures, and to regard them as freaks of nature or "formed stones". Some of the medieval writers supposed that the plastic force producing the fossils came from the stars instead of the earth.

FOSSIL INSECTS
Ask your fundamentalist friend to explain these fossils

This interpretation of fossils persisted without serious question for about 1,500 years, until Leonardo da Vinci advanced the view that fossils were the remains of animals that once lived on the sea floor. Opposed to this idea two new explanations, conforming to the Christian teachings, were invented. One supposed that the fossils were placed in the earth by the Creator to deceive man; the other claimed that they were the remains of animals killed during the great Deluge of the time of Noah. This latter idea became very popular and resulted in the formation of the "school of deluvialists". During the 17th century several additional absurd explanations were offered, including that of Martin Lister (1670), who believed that different kinds of rocks produced different types of fossils; and that of Whiston who suggested in his "New Theory of the Earth" that after the fall of man the earth began to rotate, and on November 18, 2349 B.C., it passed through the tail of a comet, which caused the formation and deposition of all fossils!

During the 18th century a series of investigators, notably Liebnitz, Hooke and Guettard, attacked the deluvialists' explanations as well as the other fantastic ones and demonstrated the true biological interpretation of fossils; although of course the dogmatic attitude of the Christian Church was not changed for more than a century later. At the present time individuals can still be found who believe that all fossils were formed in the "flood" or were invented to deceive and mislead mankind.

In view of the influence which the biblical story exerted on the interpretation of fossils, it is not surprising that the medievals tried to associate the fossils with characters mentioned there. At some localities bones or skeletons were found which because of their great size were determined as the remains of some of the giants mentioned in the Old Testament. One of these, found in Austria in 1645, for example, was supposed to be the skeleton of Og, (King of Bashan) whose bed is recorded in Deuteronomy as being 18 feet long. All of these bones were shown later (about 1796) by Cuvier to be the remains of mammoths. A tooth displayed by a Roman Catholic Church in Valencia was supposed to have belonged to St. Christopher; and a large bone, regarded as a Saint's arm, was borne through the streets in reverent triumph whenever rain was needed. Both the tooth and the arm were subsequently proven to belong to mammoths. Perhaps the most famous of these cases was the skeleton described by Scheuchzer from Switzerland. He named the specimen "Homo Deluvii Testis", supposing it to be the remains of one of the infamous men who brought about the calamity of the flood. Cuvier later showed that the skeleton was that of a large salamander!



Ancient Life History of the Earth: D. Appleton & Co.

HOMO DELUVII TESTIS
From an old woodcut of the original specimen, still preserved in the Haarlem Museum

Most civilized people to-day recognize the real nature of a fossil; but that knowledge has been gained only after eighteen centuries of misunderstanding.

BOOKS

IN QUEST OF GORILLAS.—Wm. K. Gregory and H. C. Raven, Darwin Press, 1937, 241 pages, $3.50.

Four of the world's great anthropologists are sent by Columbia University and the American Museum of Natural History into the Africa of Du Chaillu, Livingstone and Stanley to observe and photograph, hunt and collect that important, but rare and little known relative of man, the gorilla. They succeeded in bringing back five adult specimens, carefully embalmed for detailed anatomic study, and a live baby, who later grew up in the bosom of Dr. Raven's family of children. Besides the learned Dr. Gregory and his co-author, the experienced explorer, Dr. H. C. Raven, the party included the witty Dr. J. H. McGregor and the athletic Dr. E. T. Engle. Gregory and Engle had additional, secondary errands on this trip, the former to study those "living fossils", the African survivors of the ancient lung-fishes, the latter to take photographs and foot impressions of African natives for study at Columbia.

Ever since Huxley summarized "Man's Place in Nature" three quarters of a century ago, anthropologists have bewailed our lack of detailed knowledge of gorilla anatomy. Such knowledge should throw much light on several problems of man's ancestry. But the two known varieties of this giant ape live in the depths of the Congo jungle and the mountains of Central Africa. Hunting out our poor relation has always been a real man's job. An expensive, well-equipped expedition, months of skillful, patient hunting, a trip across the entire African continent were required. Even with recent facilities for travel the task was formidable. Then there were the problems of careful shooting, so as to make embalming effective, and of transporting these giants, weighing around four hundred pounds, through dense, pathless jungles, down to the coast and across the sea.

But all that is but the technical part of the story, which never mars the racing pages of this absorbing book. For this is travel in a world of wild and magnificent scenery, across the Great Rift Valley and the wonderful Lake Region, up into the mountains, down into the Congo Basin. This world teems with life, plant, animal, human. Every page has its verbal picture of episode, strangeness, interest and fun—protectively colored lizards that disappear when they stop, house-geckos that walk on the ceiling, queer mole-like creatures, kittens with fur patterns between spots and stripes, ant armies with plodding workers and belligerent soldiers, ostriches that "stalk grandly", giant vipers hunted with a split stick.

Gregory, the dignified Columbia Professor, turns out to be wholly human. He is quite at home with the dancing, laughing, begging natives. He makes friends with the jungle pygmies. Sympathetically he exposes native foibles. There is the native chief, dressed in white duck and sun helmet, who rides a nickel plated bicycle before the crowd, bowing grandly at the admiring applause. And that other native "gentleman" who laid a board floor so he could hear the tramping sound of his white man's shoes. We read of the death-dealing "Leopard Society" executing native justice, of a sable Juno of queenly poise, of a dainty Venus of quiet voice, of plaintive melodies which fade into memory's "Lost Chords". Even the calmly efficient Dr. Raven succumbs to the friendly spell of these simple people and confesses to negotiating the sale of a wife (not his own, of course) for two dollars. Most of the tale is told by Gregory, who is finely gifted with vivid description. He goes on gorilla hunts, of course, but largely as observer. Dr. Raven being the official hunter. Both contribute to the stories of the hunt.

By means of booming signal guns word was sent out to all the villages to watch for gorillas, and by drums the reports came in. The pygmies turned out to be good trackers. Again and again the hunters drew close to the elusive giants, heard their stomachs rumble, saw the bushes shaking, caught a glimpse of a hairy arm, more rarely of a peering face. Often some brave male would rush them, but would stop before becoming visible and retreat noiselessly after covering the silent earlier departure of his band. Now and then gorillas have attacked men, maiming or killing with their great strength. However, none of our hunters ran into danger, except Raven perhaps, when he remained behind to finish his hunting after the others had started home, and came down with sleeping sickness, two kinds of malaria, hookworm and ascariasis, all at the same time. But a missionary doctor pulled him through, and every one arrived home safely with a precious cargo of specimens and a tale completely delightful to read.

—*Allan Broms*

THE SOLAR SYSTEM AND ITS ORIGIN. — Henry Norris Russell. 144 pp.—MacMillan, N. Y. 1935.

Though the first formulation by Swedenborg of the famous Nebular Hypothesis on the origin of the solar system is now fully two centuries old, the recognition of its fatal flaws dates only from 1900 when Moulton examined mathematically its impossible dynamics. The outstanding difficulty was that the momentum of revolution of the planets and satellites was several times that warranted by their masses relative to that of the Sun.

The immediate result was Chamberlin and Moulton's Planetesimal Hypothesis, the first of the tidal theories (later to be modified by Jeans and Jeffreys) which explain the solar system as torn from the Sun by the gravitational pull of a passing star.

But even at the turn of the century only the most obvious of the facts to be explained had been learned. The planets (including the vast horde of asteroids) all revolved in one direction and nearly all in one plane, as did most of their satellites. That rule applied also to their known rotations and that of the Sun. All this definitely pointed to a common origin.

Now, however, an array of facts has been assembled of which our generation may well be proud. Theory, too, has made notable advances. But the net result of this accumulation of facts, physical, chemical, and mathematical, has so far only added difficulties which no theory of origins has consistently explained. The very presence of planetary atmospheres, the existence of the satellites and particularly of comets, offer special difficulties.

Recent theories have tried to include all this detail of obstinate facts, but with dubious successes. Jeffreys substituted a stellar collision for mere tidal disruption. Nolke borrowed the planets and comets from a nebula through which the Sun may have passed. More recently, Lyttleton, following a suggestion by Russell, assumed the original Sun a binary star, disrupted by a third passing star to form our solar system. Other theories, apparently of little promise, have yet to be worked out in theoretical detail.

Two thirds of this book is devoted to the facts which must be explained and, despite its technical thoroughness, it is unusual for its clearness. The last third covers the theories of origin with the same lucidity. There is none of the usual assumption of scientific certainty, no effort to make evolutionary drama out of the puzzling array of facts. Yet the fundamental fact, that some two billion years ago the Great Event of Planetary Birth took place,—that fact is amply and convincingly demonstrated by independent, yet singularly consistent, evidences. Altogether, as a summary of our present knowledge of our solar system and as a critical evaluation of all theories of its origin, this small volume is quite unsurpassed.

—*Allan Broms*

Fundamentalist Follies

FROM COLD TO WARM BLOOD

By E. T. Brewster

Taylor University at Upland, Indiana, is the sort of institution that picks its teachers for the "soundness" of their beliefs. If, in addition, they turn out to be competent scholars, that is so much to the good.

The Doctor of Philosophy who heads the Department of Biology is, naturally, no Evolutionist. Yet, as he remarks (*Christian Faith and Life*, February, 1932) " . . . a student, in order to be able to hold any theory, must know all theories," and there is no use, in these days, trying to suppress information. "Doubtless the theory of evolution should be presented; nor will this be dangerous, since its arguments are so easily met. No one has yet found a single evidence (*sic*) of any form of animal life abridging the gulf between the cold-blooded animals and the warm-blooded ones."

Oddly enough, it happens that in the *Scientific Monthly* for May, 1932 (pp. 421-428) appears a summary of seventeen years of work by Dr. Francis G. Benedict, Director of the Nutrition Laboratory of the Carnegie Institution of Washington dealing with this very point. Dr. Benedict stands among the dozen leading men of the world in his field, and his long investigation has employed every device of method and apparatus. Even the familiar thermometer has been replaced by an elaborate electrical tool; while the number of separate determinations approaches a thousand.

"In this gap between cold-blooded and warm-blooded animals," the article concludes "three striking intermediary steps have been noted"—instead of none as set forth at Taylor.

First, there is an African python, studied in great detail. It is, of course, cold-blooded. That is to say, under ordinary conditions, lying quiet, its body temperature is slightly lower than the air around it, because, like other living things, it is all the time evaporating water. But an active snake at once elevates its temperature sometimes as much as ten degrees above its environment.

This particular serpent is a lady—one should perhaps call her a pythoness—and most fortunately she laid some twenty eggs and incubated them. She ought, according to Indiana physiology, to have incubated in vain, not warming her offspring. As a matter of fact, lying quiet, with the air around her at 86, she herself registered 93, as against 98.6 for a "warm-blooded" creature discharging similar maternal duties.

So an incubating pythoness does bridge the gulf. Moreover, this fact, though never before so carefully tested, has been known for at least a couple of human generations.

Then there are the tortoises. These "have a much higher heat production . . . than do the snakes, alligators and lizards . . . and hence may be considered to occupy an intermediate stage between these animals and the warm-blooded."

Finally, "the hibernating animals likewise represent an intermediate stage . . . Indeed, the body temperature of a hibernating warm-blooded animal may easily be the same as that of the snake, alligator, or fish, for its temperature will fall with that of the environment nearly down to the freezing point of water without resulting in the death of the animal."

Besides these "forms of animal life abridging the gulf between the cold-blooded animals and the warm-blooded ones," there is the notorious "duck-bill platypus," which Dr. Benedict has not yet studied for heat-production and body temperature, though the general facts concerning it have likewise been known many years.

This strange creature, in addition to laying eggs like some reptiles and incubating them like others, has all sorts of reptilian features of an anatomical sort. In fact, with its eggs and its primitive milk apparatus and its beak in place of teeth and its distinctly reptilian bones, it is precisely the "missing link" which the Evolutionist needs to connect the hair-covered mammals with their scaly ancestors. The important point for us here is that "the duck-bill" though a true mammal and warm-blooded, keeps its blood considerably cooler than less reptilian members of the class.

Even we men, who carry our heat-regulating devices about as far as any creature ever does, by no means always maintain a perfectly constant blood heat. A human being in a fever may run a temperature of 105 or 106 and live to tell the tale. Or he may cool his blood down to 94 or 95 and recover. So even we are just the least bit "cold-blooded," and in our small way another of those non-existent bridges to lower things.

Once more, then, as so many times before, a Fundamentalist theorizer encounters the Prophet Balaam's old trouble with his ass. The dumb critters will speak—and they always say the wrong thing for Balaam.

Boners From Exams

Leuwenhock is the father of bacteria.

The earthworm has a long elementary canal.

The Rialto is the business part of Venus.

Funnymentals

"Animals, which move, have limbs and muscles; the earth has no limbs or muscles, therefore it does not move. It is angels who make Saturn, Jupiter, the sun, etc., turn round. If the earth revolves, it must also have an angel in the centre to set it in motion; but only devils live there; it would therefore be a devil who would impart motion to the earth.

The planets, the sun, the fixed stars, all belong to one species—namely, that of the stars. It seems, therefore, to be a grievous wrong to place the earth, which is a sink of impurity, among these heavenly bodies which are pure and divine things."—Scipio Chiaramonti, quoted in "The Great Astronomers," p. 103.

"It is generally held among scientific men that it is the action of the sun upon the earth that causes the latter to revolve upon its axis."—J. C. Derfelt in **Fax** "Official Organ of the American Science Foundation." March, 1932, p. 6.

"Then we have Mendol (sic) who experimented with flowers and discovered a rule and thought it would apply to human beings but it did not."
Prof. C. H. Briggs. B. E, **idem**, p, 9.

"The order that is called Phizapod (sic) . . . have no cilia, but move about by a queer method called ectoplasm . . ."
—Christian Faith and Life, May, 1932,

"Darwin with all the fuss and feathers and bluster and insane ballyhoo that he could muster, after admitting the mutation of species to be profound ignorance, has employed every art of lying, dishonesty, superstition, flagrant imagination, misrepresentation, fool guessing, and ignorant suppositions in order to junk the blood of human beings with the blood of every beast of the field, every reptile of the marsh and vermin of the sewer, all the way from monkeys back to the larval ooze of primal seas.

"Any thinking man, who knows what evolution is, would rather be known as a horse thief, a pirate or a cowardly bushwhacker, than to be known as an evolutionist . . . Evolution is a pack of damnable lies as black as the soot on the walls of hell; too filthy for carrion, too shameful for dens, too foul for the sewer and too prostitute for Jezebel or Semiramis." —Rev. R. L. Stephens, Anti-atheistic Tract Depot, San Antonio, Texas.

Asexual reproduction is that kind in which no pleasure or benefit is derived by either party.

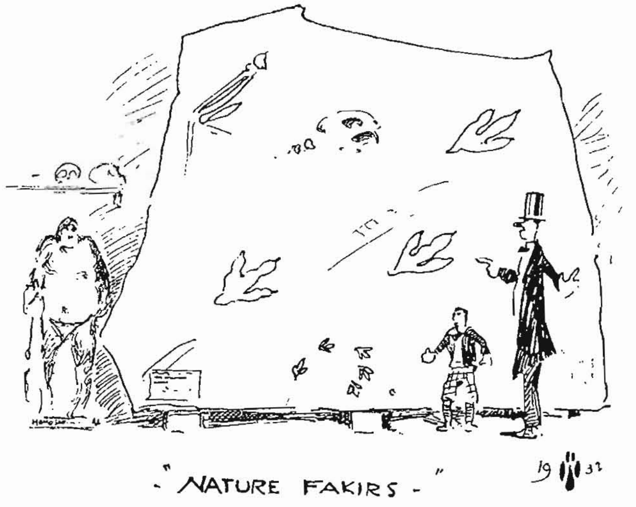
A compound shoreline is one that moves in and out at the same time.

The chief argument against the nebular hypothesis is that it would make the sun revolve around the earth every few minutes.

The axis of the earth is an imaginary line on which the earth takes its daily routine.

The difference between air and water is that air can be made wetter and water can not.

Teachers are invited to report "Boners".



- "NATURE FAKIRS" -

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TEN ISSUES A YEAR

So many of EVOLUTION'S subscribers are teachers and students who travel during the summer that we've decided to publish only during the ten school months, skipping July and August. All old subscriptions at the $2 rate will be extended the two extra months.

We're mailing this issue in envelopes under postage so EVOLUTION's resumption will not be overlooked. The next issue (Sept.) will go under second class entry.

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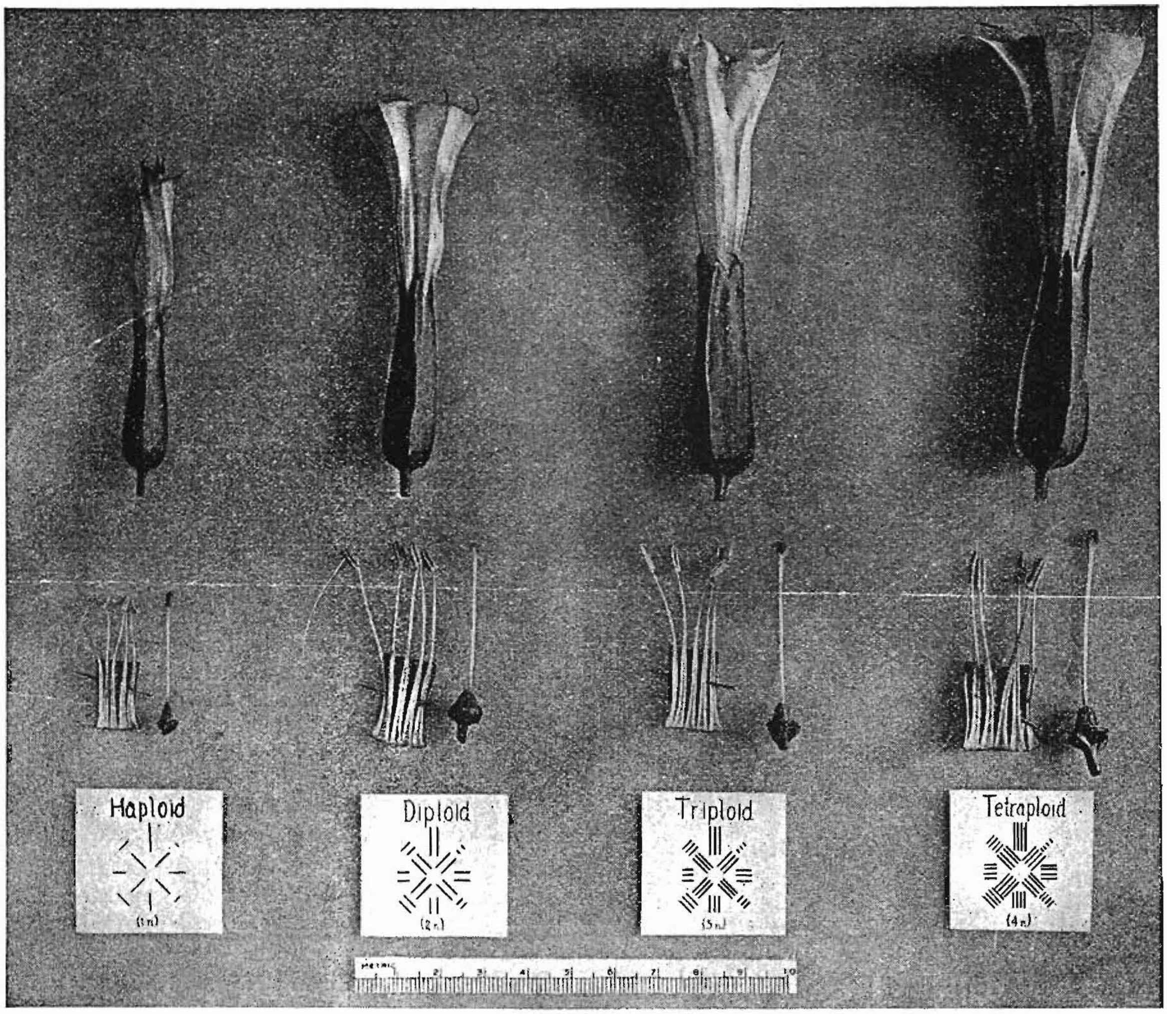

Courtesy, Carnegie Institution of Washington, Station for Experimental Evolution.

Flowers caused to evolve with *colchicine* ***See Page 12***

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EVOLUTION'S EDITORIAL FAMILY is growing. The Scientific Advisory Board is strengthened by the addition of Dr. Alexander Goldenweiser, Professor of Anthropology at the University of Wisconsin, and Dr. Clyde Fisher, Curator of the Hayden Planetarium at the American Museum of Natural History.

To the group of Contributing Editors we welcome:—Melville P. Cummin, Artist and Naturalist, associated with the American Kennel Gazette; Mrs. Miriam DeFord Shipley, for many years active with Maynard Shipley in championing the cause of Science Freedom through the Science League of America; and Dr. Nathan S. Washton, Director of Biological Sciences, Kittatiny Camp, Layton, N. J., and Merit Badge Counselor in Nature Study, Boy Scouts of America, who will conduct a special Nature Study column for youngsters.

Some Very Fancy Pussyfooting

LAST summer a discharged school teacher, Laura Morris, on trial before the school board at Waynesburg, Pa., was reported to have defended herself against the accusation that she had "taught that man is descended from monkeys" with the statement that she had done no such thing, but had "merely mentioned it as a joke"!

In connection with this case the Philadelphia Bulletin interviewed some of the leading school dignitaries of that metropolis and reports (August 13, 1937):—

> **No Monkey Theories Taught Here**
>
> Both Dr. Edward E. Wildman, director of science education in the Philadelphia Public Schools, and Dr. John L. Haney, Principal of Central High School, join in denying that "the theory that man is descended from a monkey" is taught here.
>
> "The old theory of evolutionists as to whether man is descended from the monkey has been over these many years," said Dr. Haney. "Such teaching is discredited and is not representative of science and so will not be found in our text books."

Observe the fancy foot work of the eminent Drs. in escaping from a tight corner. A straightforward answer would have made difficulties, either with scientists or with the fundamentalists in Philadelphia. So, hoping to remain in the good graces of both camps, they speak with a double tongue and make a statement that can be interpreted in two ways. The scientist can say: "Technically correct. Man is not descended from any existing monkey. Man and monkey are descended from a common ancestor." But Dr. Haney knows the fundamentalists will not make this fine distinction. They will approve Dr. Haney's statement, understanding him to mean that man and monkey are not related at all and that the fact of evolution itself is discredited. Dr. Haney would have a hard time finding a single trained biologist in the Philadelphia High Schools or at the University of Pennsylvania to support such a position. It would make him a laughing stock in the scientific world. On the other hand, to admit that evolution is accepted universally in the world of science, and that it is taken for granted in all serious biology teaching in High Schools and Universities, would bring the fundamentalists down upon him. So he pussyfoots.

He is by no means an isolated phenomenon. We merely mention him since he permitted himself to be quoted. His attitude is quite general among school officials. Under present conditions the teacher of intellectual integrity who refuses to make statements with double meanings, who gives an unequivocal answer to questions, usually remains a class room teacher or is "weeded out" long before reaching the higher executive positions in the schools. We know a few brilliant exceptions, and to them all honor, but jesuitism seems a characteristic fitting for survival as school official in a world half scientific, half fundamentalist.

The remedy? Spread science among the people, until they learn to appreciate the uncompromising honesty of the research scientist and demand the same high standard of the officials entrusted with the education of our youth.

● *L. E. K.*

"The biologist knows that he is temporary custodian of riches of an amazing personal kind—riches that multiply with the sharing—and that for the good of man and of nations these riches must be shared more effectively."

● *—Oscar Riddle.*

An Invitation to Biology Teachers

A Committee of the American Association of Biological Societies has recommended and offered to aid in the formation of a national association of those who teach biology in secondary schools. It is a deplorable fact that at present the 20,000 high school biology teachers are a scattered host, unable even to make contact with each other and powerless to cope with the problems that confront them as teachers of life science. Every high school biology teacher that would like to help remedy this situation and aid in the preliminary work of forming a National Association of Biology Teachers is invited to communicate at once with Dr. Oscar Riddle, Chairman, Committee on Teaching of Biology, The Union of American Biological Societies. Address: Carnegie Institution, Station for Experimental Evolution, Cold Spring Harbor, N. Y.

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Prehistoric Life In California

By CHARLES L. CAMP

Director of the Museum of Paleontology, University of California

IMAGINE, if you will, a telescope so constructed as to allow a peep back millions of years into the past. What would you not give to look through such an instrument—to study the progress of human history through the ages as though you were looking at a three dimensional moving picture—or to witness the procession of animal life during the immense period before the development of man?

Such an experience may never be realized but one can nevertheless examine the past by studying the fossils which are found in the earth's crust. Fossils are the remains, sometimes petrified, of the life of ages long gone by—before man appeared as a civilized being.

The most common fossils are shells and bones of animals, and leaves and stems of plants. We also find tracks, borings, casts and other products of plant and animal life such as natural gas, coal and oil—fossil substances of the utmost importance as reservoirs of power, handed down as a heritage from the distant past, and of fundamental necessity in our present stage of mechanized civilization.

A glance at the fossil record shows that life has existed on this earth for hundreds of millions of years—a prodigious time in which the whole course of written history is the mere flicker of an eyelash. The record also shows that nearly all forms of life have been changing or evolving in habits, body-form, activity, mentality and emotional make-up. Little weak forms become great strong animals in the course of evolution and the great strong creatures exist royally for a while and suddenly disappear leaving other little ones to grow up and take their places. The elephant is descended from a little rabbit-like creature—the giant dinosaurs evolved from small reptiles about the size of a rooster.

It appears evident that man himself has not existed long on this earth. His remains are found only in about the last one thousandth part of the fossil record. He has evidently been here for not much longer than a million years and only in the last one-hundredth part of that time—only in the last 10,000 years at most—has he discovered the methods of organizing himself into what we call civilized society. His conquests over the animals of his neighborhood were made by superior intelligence. He learned how to kill some and tame others. He changed wolves that killed his sheep into dogs that guarded them, unruly buffalo-like cattle into placid milk-cows. He learned how to ride and harness the fiery wild-horse, the temperamental reindeer and the nimble South American camel or llama. He made over the fierce, active wild boar into a fat, lazy tank of lard and bacon. He captured wild sheep in the mountains of Asia and caused them to produce more wool, mutton and less brains. He subdued the elephant and turned him into a live tractor, but he has never really changed the elephant because he has not induced him to breed in captivity. Man has therefore changed his animals by selecting those which he desired, breeding from them and killing or neglecting the others. Nature has doubtless worked in much the same way in the course of ages—eliminating the unfit and preserving the advancing types. We cannot be sure of the method but we can be sure of the fact that most of the animals of the past, including man, have been changing or evolving from one stage to another in the long course of time. Here is a little of the evidence at our very doors.

Fossils of ancient life are abundant in North America and particularly so in California. In fact we know more about the world of life in California just before the coming of man than anywhere else. This record has been preserved in the asphalt pits of Rancho La Brea in Los Angeles, in the caves of Shasta, and in many other natural burial places.

One hundred thousand years ago California was a wild and savage land. The forests found today in the region of Monterey extended southward along the coast. The southland received more rainfall than at present and the grass grew higher. In this grass-land one might have

Painted by Charles R. Knight *Copyrighted by the American Museum of Natural History*

RANCHO LA BREA — CALIFORNIA LONG AGO

seen herds of horses, not very different from the present wild horses of Asia, snorting stallions guarding their seraglios of mares. Crouching in wait for the colts and strays lay great lions, larger than those of Africa. Bands of huge-headed, uncouth wolves roamed through the country following herds of bison similar to those found on the plains in the frontier days.

In the thickets herds of elephants of mammoth size rested during the heat of the day and with them foraged clumsy coarse-haired beasts of slow movement and still slower wit—beasts with huge claws on the front feet which they doubled under them as they lumbered along—these were the ground sloths, related distantly to the smaller tree-sloths and ant-eaters of South America today. Stalking through the cypress thickets were solitary, tiger-like cats with huge teeth, like swords, in the fronts of their mouths. They killed and ate the sloths and smaller elephants — pouncing upon them with great force and driving their terrible sabre-like teeth through the thick hides—ripping gashes and cutting across exposed vessels. The remains of the carcasses were gnawed by the wolves and plucked to bits by the giant vultures—much larger than the California Condor. Ungainly camels, droves of grunting peccaries, an occasional blundering tapir, huge bears, delicate antelopes and deer, mountain lions, coyotes, gophers, bob-cats, badgers, skunks, birds, toads, turtles and all the lesser fry of the present day completed this picture of wilderness life as it was lived one hundred thousand years ago in the valleys of California.

Two Million Years Ago

Proceed backward two million years or so and note the differences in the life of California at that time. Here again are herds of horses—a little smaller—a little stronger than those of today. The elephants, mostly of the Mastodon group, are shorter-legged, with four tusks instead of two, and with longer lower jaws, long low heads, simple teeth and possibly shorter trunks. The ground sloths are just beginning to straggle in from South America, along with them are curious animals like giant turtles or armadillos with a dome-like crust of bony scales all over the back and tiny little feet, tail and head peeping out from under this big shell—there are the glyptodonts—another South American group that visited us for a time. The camels now include some graceful gazelle-like forms and some with spindling legs and necks like a giraffe.

There are plenty of rhinoceroses and these become extinct in North America after this time. The bison have not yet appeared—they will come in later from Asia. The wolves look and act like hyenas with bone crunching teeth and short thick jaws. There are no giant sabre-toothed cats or lions in the Pliocene—their place is taken by a smaller kind of sabre-toothed cat about the size of our mountain lion and bearing more delicate sabres than the Pleistocene form. The antelopes are the predecessors of our plain antelope. There are curious little deer with flattened antlers in this California of two million years ago.

Thirty to forty million years ago the animals of California were still more different from their successors of today. At this time we find but meagre faunas which must be compared with the well known fossils of the plains and rockies to make them understandable. The horses were about the size of sheep, with three toes on each foot, and with teeth fitted only for browsing, not for chewing hard grasses. The rhinoceroses were more like the horses than any rhinos of today. Some of them were rapid runners, some were stodgy marsh living types. The dog and cat-like forms were small-brained, less intelligent, slinking, sneaking forms without the highly developed teeth of later kinds. There was a group of giant animals called titanotheres related to the horses and rhinos but with a double forked horn rising from the end of the nose. These powerful creatures, in bulk much larger than the present rhinos and apparently well able to take care of themselves, became suddenly extinct for some unknown reason. There were giant lump-jawed pigs and curious big-jowled creodonts, (primitive browsing animals, piglike in habits, and distantly related to the pigs and deer). The elephants had simple teeth, long jaws, minute tusks and probably very short trunks—they were much smaller than the modern elephants.

When Waters Covered the Land

During most of the period before the last forty million years the parts of California west of the present Sierra Nevada were covered by the sea. In this ocean lived in very early times, reptiles related to the lizards and crocodiles, fishlike in form with fins and flippers, never coming out on land, even to bear their young.

These big animals also perished—as the whales are destined to do, perhaps in the near future, under the inroads of man.

While the great fish-lizards churned through the seas and the flying bat-like reptiles soared above, the land was inhabited by a strange host of creeping, ambling and rapid running cold-blooded animals of which the dinosaurs were the most conspicuous. At this time the most obscure forms were tiny little warm-blooded hairy mammals related to our opossums, moles and shrews.

The close of the age of reptiles witnessed the destruction of a world of life that had been slowly built up during some 300 million years and was the signal for the development of the modern types of birds and mammals that live about us today. Some of these in turn are rapidly passing out of the picture. The grizzly bear is now extinct in California, the giant condor is nearly so, as well as the California grey whale, and the Roosevelt elk. Even in Africa the great herds are vanishing before the onslaught of the frontiersman—just as the bison did in America. The world is due for constant changes. Change is the order of the day but man should have some control over his destiny if he will but use the intelligence which he may bring to bear upon the complex problems of his social scheme.

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A PEEP AHEAD

The next issue of EVOLUTION will bring you "The Evolution of The Dog" by Leon F. Whitney; "The Dynamic View of Nature" by Alexander Goldenweiser; "Darwin and Evolution" by Wyman R. Green; "The X-Ray and Evolution" by C. P. Haskins; and other articles dealing with current discoveries regarding the *process* of evolution.

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Fossil Plants and Evolution

By WM. C. DARRAH

Research Curator of Paleobotany, Botanical Museum, Harvard University

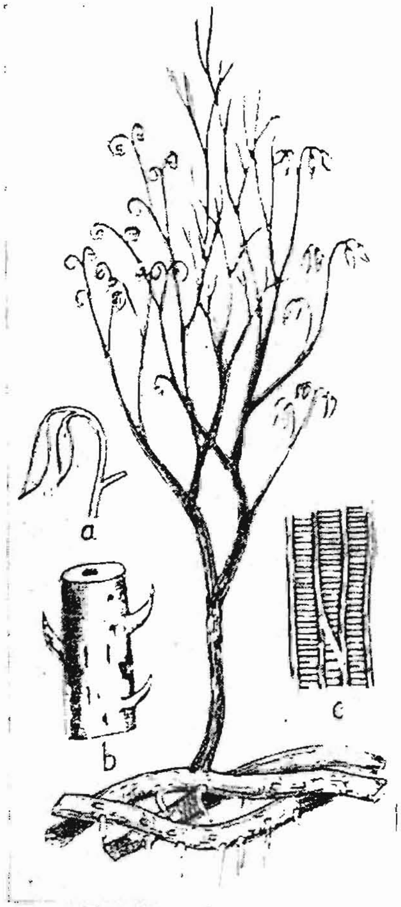
FEW fossil discoveries have done more to complete our knowledge of the continuous evolution of the plant kingdom than the discovery of the simplest and oldest land plants.

Almost eighty years ago—in 1859—Sir William Dawson discovered an extremely simple-looking plant in the Devonian rocks of Gaspé. This plant, to which he gave the name *Psilophyton,* had little more than the bare essentials for existence on land. The shoot, scarcely a foot in height, had a bit of underground stem without roots and a series of forking branches without leaves, which bore small terminal spore cases crowded with small spores.

For more than fifty years Dawson's plant was considered to be the inaccurate restoration of an imaginative paleontologist, without scientific interest or value.

During the closing years of the World War two British paleobotanists, Robert Kidston and William Lang, began a series of investigations on the Rhynie Chert, which occurs in Aberdeenshire, Scotland. The Rhynie Chert is a flint-like rock formed by the accumulation of silica from silica-bearing ground water. Fortunately the silica accumulated in a peatbed crowded with the successive generations of small plants which lived in the swamp more than 300 million years ago.

It so happened that the silica in solution acted as a preservative against decay, and, as a result, not only fossilized the plant debris but also preserved the microscopical cells and tissues of the organisms. The life history of these early Devonian plants is therefore known in great detail and with amazing completeness.



The Earliest Land Plant
Psilophyton
Reconstructed by Dawson

Immediately it was recognized that *Rhynia,* the most abundant of these Scotch plants, was a close relative of Dawson's *Psilophyton* which had been disregarded for half a century.

Botanists enthusiastically received the results of these investigations on early Devonian plants. Their salient features are essential to understanding the evolution of all higher plant groups. These small plants are grouped together into one "order" technically termed the *Psilophytales.* They not only have the extremely simple external appearance of *Psilophyton* as described by Dawson, but are accompanied by an equally simple and undifferentiated internal organization. The stem is supported by a slender central cylinder of wood.

The epidermis of the stem contains many breathing organs or stomata showing that the plant was able to live on dry land and manufacture its own food, despite the fact that it bore no leaves which, in more evolved plants, normally carry on food production. This group of ancient plants had acquired little more than the bare necessities of a land existence, eating to live and living to reproduce their kind. There were no embellishments.

It is not quite accurate to speak of these plants as the earliest plants although they are almost as simple as botanists can conceive. Within the past two years, very similar but still more ancient plants have been discovered in the Silurian rocks of Victoria, Australia.

Through these remarkable discoveries we can study the anatomy and reproductive structures of long-extinct plants in detail.

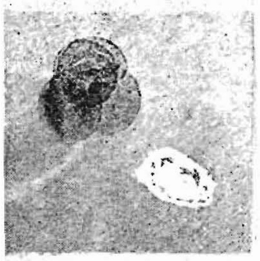
All of the older Devonian plants reproduced by spores — small single-celled structures capable of being distributed in wind or water and living independently of the parent plant for long periods of time. Spores are so resistent to decay and destruction that they are familiar fossils, despite their minute (usually microscopic) size. For example, a Devonian plant named *Sporocarpon* from the vicinity of Delaware, Ohio, is known in its late embryological stages. In figure two, the photomicrograph shows a cluster of four spores, or tetrad, which have grown from a spore-mother cell. These spores are 280 million years old.

Spores are sometimes so abundant and accumulate in such great quantities that they form entire coal beds. So-called cannel coals and many oil-shales are largely composed of isolated spores.

These simple ancestral spore-bearing plants gave rise to greater and more diversified plants. Then development of wood soon made increased size possible. The great Carboniferous spore-bearers, such as *Lepidodendron,* attained an over-all height of 100 feet even with the obstacle of a scant supply of wood. In these trees, the progenitors of our existing lowly ground pine, the fleshy cortex was so thick that German botanists have named them "rindenbaume" or rind-trees.

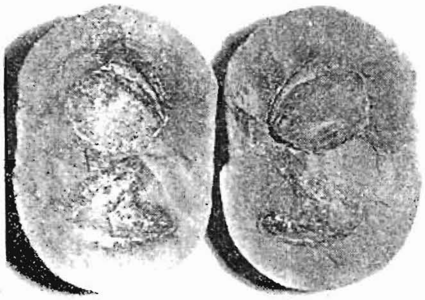
Nevertheless, spore-bearers are limited in their potentialities. A large number of spores must be produced so that the successful germination of a few is assured. This is wasteful and new races of plants gradually produced fewer spores of two kinds, male and female, which were supplied with mechanisms for survival during unfavorable periods. The culmination of this trend was the evolution of the pollen (male) and the ovule (female). The fertilized ovule grows into the familiar seed.

One of great gaps in the story of plant evolution at the turn of the twentieth century was the transition from the higher spore-bearing plants, such as the ferns, to the lower seed-plants, in cycads and conifers, our cone-bearing trees.



Spores of Sporocarpon
280 millions years old
magnified 100 times

Codonotheca
a pollen bearing organ
from Illinois



Two Seeds of a Seed Fern
A Nodule from the Carboniferous
200 millions years old

The final discovery of the "missing-link" in 1903 verified a prediction made fully twenty years earlier. The discovery of true seeds in actual connection with fern-like foliage fulfilled the requirements for a perfect missing-link. In 1883 the Austrian paleobotanist Stur noted that among the abundant remains of fossil ferns of Carboniferous age, there were many kinds for which no examples of fruiting specimens had ever been observed. Surely these were not ferns—even the more negative evidence of the absence of fruiting examples needed consideration. For a time Stur's question went unanswered, although in 1899 certain petrified stems were recognized as having anatomical relationships with both ferns and cycads. Upon these stems was bestowed the name *Cycadofilices,* or cycad-ferns. The paleobotanist was getting close to an answer, but not yet was he justified at anticipating a conclusion.

It remained for Kidston and Scott in England and the late David White in America to discover actual remains of seed-bearing ferns which were immediately classed in a new group—the *Pteridosperms,* or seed-ferns. We are now supplied with sufficient data to know that the names Pteridosperms and Cycadofilices refer to the same group of plants.

The pollen-bearing and seed-bearing structures of Illinois Carboniferous seed-ferns immediately preceded the flowering plants. Botanists generally consider them the remote ancestral stock of all flowering plants. It is a tremendous gap between the Carboniferous seed-ferns which lived 200 million years ago and the earliest recognized flowering plants of 120 million years ago—plants which lived during the Cretaceous age of dinosaurs. During the intervening 80 million years many profound changes took place with numerous trials and errors toward the attainment of true flowers.

There are several so-called missing-links or transitional types in the evolution of the flower which have as yet escaped the scrutiny of the paleobotanist. Past experience has taught us that much of the evidence is probably housed in collections already preserved in museums but has simply been overlooked.

Only a century ago the study of fossil plants was in its formative stages. Gradually a large number of facts, substantiated by hundreds of important discoveries, has accumulated, until we are in possession of the whole picture of the evolution of land plants. The study of paleobotany itself has evolved from the days when it merely dealt with collections of natural curiosities. Today it has taken its rightful place with the other fields of biological thought.

The upward course of plant evolution is an irrefutable fact and the means by which this progress is measured is nowhere better manifest than in the earliest Devonian Psilophytales and in the seed-ferns.

Is This Where Life Begins?

From United States Department of Agriculture

THE borderland between living organisms and chemical substances is one of the frontiers of science in which exploration is active. In this borderland exist the viruses that cause a wide variety of diseases that affect both plants and animals, including man. Whether a virus lives or is a chemical substance without life is a question that puzzles both chemists and biologists. As exploration proceeds, the answer is coming more and more to depend on a finely drawn definition as to what distinguishes living from non-living substances.

H. H. McKinney, research worker of the U. S. Department of Agriculture, working with the virus of the common mosaic of tobacco, has developed evidence that the virus has a very simple mechanism of inheritance. In the past, scientists have usually regarded inheritance as a distinguishing characteristic of living organisms. In popular thought, reproduction or multiplication of a substance may seem a convincing evidence of "life" but science knows of many strictly chemical and non-living substances that increase in a manner which is strongly suggestive of the reproduction in organisms.

Mr. McKinney has developed evidence that the virus of common mosaic of tobacco mutates, giving rise to new viruses which induce mosaic symptoms quite different from common mosaic. Certain of the many virus characteristics mutate more frequently than others. Some of the new virus forms, or mutants, also mutate or give rise to still other new viruses or sub-mutants. Of the many virus characteristics of the common-mosaic virus some are retained by its mutants and sub-mutants. Some of the characters which are peculiar to certain mutants also tend to persist in subsequent mutants from these.

Mr. McKinney and other investigators have found that certain types of virus mutation are more likely to occur under certain conditions, for example, under the influence of high temperatures.

The virus cannot be identified under the most powerful microscope. It will pass through fine filters and retain its disease producing character. To identify a virus, experimenters are driven to observe its effects on the plants it attacks. The virus multiplies in the plant, but no experimenter has been able to cause it to multiply outside the plant. Some viruses can exist in more than one species of plant, and two viruses causing identical symptoms in one species may be distinguished by differences in the symptoms on another species.

Several investigators have experimented with the crystal-like virus protein. They have been able to dissolve this and cause all the known signs of the disease in tobacco and other suitable plants which were inoculated with the solution. Some workers have considered the crystallization test as proof that the virus has been isolated as a pure chemical substance. However, this test alone is not accepted as positive proof because there is still a possibility that the virus may be present as an impurity.

Although Mr. McKinney considers that the "virus and its mutants doubtless reflect a series of closely related compounds which function essentially as genes," he takes the position that this conclusion is still consistent with the idea—held by some investigators—that the virus represents a complex protein molecule. Some investigators consider the genes of plants and animals to be proteins. The virus particles may represent free parasitic genes of a primitive type, but nevertheless similar to the genes which occur normally in plants and animals.

The Glacial Period

By J. HARLEN BRETZ

Professor of Geology, University of Chicago

KINDLY visualize a brick. Chicago is built almost entirely of such bricks. It is also one of the greatest brick producers. Brick is made from clay. Chicago bricks from Chicago clay. That's easy to understand. But how was the clay made? Someone answers "Why, the clay was here in the first place."

Chicago uses vast quantities of crushed rock in concrete work. The rock is limestone, blasted out of immense quarries in and adjacent to the city. These quarries are located where the limestone is close to the surface. In most places it is buried beneath 50 to 100 or more feet of the clay. Now if the clay was here in the first place, the limestone either was put under it afterward (which is absurd), or was made before "the first place" (which is equally absurd). The limestone is beneath the clay and therefore is surely older than the clay. What you meant by "the first place" was "before Chicago was started."

Chicago uses vast quantities of sand in its building operations and in raising its railroad grades above street grades. Most of this sand comes from the dunes in northern Indiana, along the shore of Lake Michigan. "Where did the dunes get it?" That's easier to answer than "where did the clay come from." Any visitor at the Dunes sees almost at a glance that the dune sand is simply the beach sand, swept up from the shore of the lake by the wind.

The brick clay, the limestone and the dune sand all were here before Chicago's history began. Only the dune sand is still accumulating, and its method of origin therefore perfectly clear. How was the clay made?

If it were necessary to witness the events of the history of the earth to know of their occurrence, we would know precious little about the subject. The old earth has been a long, long, long time in the making, and Man as an intelligent observer has been writing records on stone, parchment and paper for only a few thousands of years.

But, happily, the processes by which the Earth has been brought to its present condition have left indelible, unmistakable records of their own. Graven on stone, too, but the hieroglyphs are wholly different from any that men ever designed. When we learn to read them, we can answer that question "How was the Chicago clay made?" Let's have a look at that clay.

We are standing now on the brink of one of the big Chicago pits. The steam shovels have dug deeply to the bed-rock, the limestone. Look at the surface of that limestone from which the clay has been removed. It is as smooth as a floor. And look at those parallel grooves and furrows across it, all directed northeast-southwest. Looks as though some great planing machine has been run across it. If we go down into the pit and scrutinize the surface of the limestone more carefully, we find millions of tiny scratches, as fine as though made with the point of a needle, and all parallel to the course of the grooves and furrows. Whatever made the surface of the limestone smooth, whatever made those grooves and furrows and tiny scratches—moved across the bedrock surface either from the northeast or from the southwest.

A Giant Planing Machine

While we are down in the pit, let's look at the clay more carefully. It isn't all clay! It has many stones in it, some three or four feet in diameter. And they have the same sort of markings on them as the bedrock! Except that they point in various directions on the same boulder.

We may assume that whatever made the markings on the surface of the bedrock, also made the markings on the stones in the clay. Then the clay which contains the boulders and which lies on the scored surface of the limestone, was made at the time the markings were made. And isn't it perfectly logical to think that the scratched boulders and stones were the tools used by our hypothetical planing machine in smoothing, grooving and scratching the surface of the underlying limestone?

Here's another significant thing. Many of these stones are not of limestone. Here's one of granite! Another of sandstone! A third one of quartzite! Here's another granite, different from the first! We shortly identify twenty or more different kinds of rock, none of them limestones. Now *where* did they come from? There's no granite under Chicago for half a mile down, as several deep wells in town tell us. Therefore the boulders of foreign rock must have been brought here in some way from some place which has a granite bedrock.

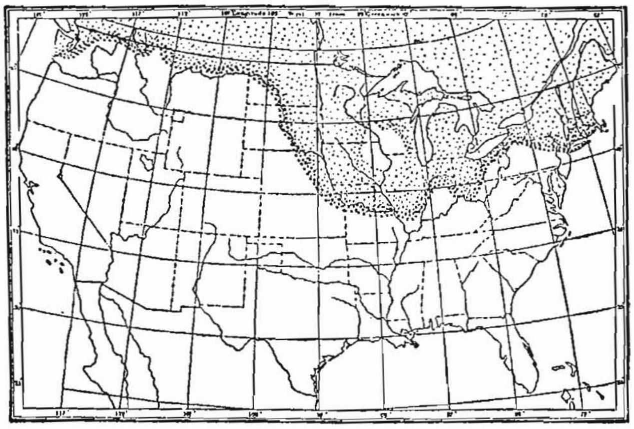
Now, what's the next step in our reasoning? You will probably beat me to the idea before I can announce it. If the granite and other foreign rock fragments were brought to the Chicago region, and if in the bringing, they were scratched and the bedrock limestone here was scratched and fluted in a northeast-southwest direction, then the granite, etc., came from the northeast or the southwest. That it came from the northeast is clear when we find that there are fragments here from the outcropping bedrock north of Lake Superior and Lake Huron. Even pieces of the native copper of the Lake Superior copper country are found now and then.

The Clay Was Left by Glaciers

But what brought the foreign boulders and stones from the northeast? What forced them to gouge and plane and smooth the underlying limestone? What ground up the softer material to make the clay? The geological agencies which shift materials about on the earth's surface, and which wear the material in transit, are waves, streams, wind and glaciers. Waves never move, or deposit, such heterogeneous material as clay and stones together, and they never mark the bedrock in the fashion we saw in the clay pit. Streams are likewise guiltless. Wind never did anything of this sort, though, admittedly, the wind does blow sometimes in Chicago. But the glaciers of our western mountains and of Alaska and of Greenland and of Antarctica make precisely similar deposits and mark their debris and the bedrock over which they move, in precisely the same manner.

So here at last we reach a conclusion that seems perfectly logical and in perfect accord with the facts. We have used the scientific inductive method in solving the problem. We have no alternative explanation except that "the clay was here in the first place"—and that's no *explanation*.

Now that we have proved that the Chicago region has been covered by an ice sheet, you may lay down that brick! We are going farther afield. We scout about Wisconsin, Illinois, Indiana, Michigan and adjacent states. Everywhere we find the same typical glacial record. Wait! We fail to find it in southern Illinois, southern Missouri, southern Indiana. We soon find that we can draw a line across the United States, from east to west, north of which is the record of glaciation, and south of which none of this record can be found. The ice-sheet spread from the northern part of the continent down into New Jersey, Pennsylvania, Ohio, in one place about 20 miles over into Kentucky, Indiana, Illinois as far south as Carbondale, Missouri, northeastern Kansas, eastern Nebraska and eastern South Dakota, most of North Dakota, northern Montana, Idaho and Washington. All Canadian territory was under the great ice-sheet. Indeed, the ice-sheet was a Canadian product for it centered near Hudson Bay and spread out in all directions. Yes, it actually moved northward from the continent toward the Arctic Sea.



The Far Flung Front of the Ice Sheet

The Ice Sheet Made Our Lakes

The influence of that ice-sheet today is manifold. Almost all of the hills and valleys of the northern states which I have named are the result of that glacial experience. Rarely do we find a region where the bed rock makes up the hills. Most of them were built up by the deposits made by the ice. The ice was a gigantic rasp, thousands of feet thick, armed below with fragments of rock picked up in its course, and this wreaked havoc with the pre-existing hills and valleys of the invaded region. Then, when the ice melted (for that is the only way it could be removed) all the detritus worn and torn off the underlying rock from Labrador southward, was left behind, resting on the planed and smoothed and scratched bed rock floor. (We're back to the clay pit, again, you see.)

The old river valleys in many places were completely filled and the streams had to find new courses. Niagara River is the most spectacular case of this sort. The new course just happened to cross a cliff of limestone and the Falls of Niagara resulted.

The multitude of lakes of northern Michigan, northern Wisconsin and northern Minnesota all owe their existence to the irregular deposition of the glacial debris. How many of the honeymooners at Niagara and how many of the fishermen in the lake country appreciate this? Oh, well—you can't blame them! Love and fish are matters of vital moment—glaciers are not.

Almost all the soils of the northern states are due to the glaciation. The glacial deposits have been worked over somewhat at the surface, rain has percolated thru and dissolved some substances, organic matter has been added from the prairie sod or the forest duff; otherwise we are farming on the ground-up debris left by the ancient ice sheet which covered nearly half of North America.

Most interesting, perhaps, is the fact that our Great Lakes owe their existence to the glaciation. Before the ice invaded from the north, these lake basins were simply broad river valleys. The ice sheet was thousands of feet thick, its surface, if like that of the Greenland and Antarctic ice sheets of today, was fairly level, but its bottom fitted down to the major pre-glacial hills and valleys. It therefore was thicker where the valleys were, and there it eroded more. Then, during the waning of the glaciation, it lingered longer in these lower places and built up the southern margins of the basins to make the dams which today withhold the lakes from flowing to the Mississippi. New outlets were found, converging to the St. Lawrence. Niagara, as I have indicated, was one of these post-glacial outlets.

(*To be continued in next issue*)

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In Praise of Natural History

By WILLIAM KING GREGORY

I

OH, LET us give praise unto Natural History;
for she hath revealed the splendor of the heavens, the majesty of celestial power.
Her fields are Space and the Universe of Light:
her dominion stretcheth from everlasting unto everlasting.
The stirrings of the atom are her province: she dwelleth among all things visible and invisible.
The motes dance and the stars of Orion move in harmony;
So shall their music delight her soul.

II

She conjureth the uttermost past: behold the sun travaileth in labor and sorrow; but at last the earth, the moon and the eleven stars spring forth from its side.
When she holdeth up her mirror to man the planets move in their turn;
the moon followeth its appointed round, the
morning star foretelleth the rising of the sun.
The earth trembleth and the waters thereof are troubled:
the winds blow and the foundations of the great deep are broken up.
Again the sea is calm: its sands drop down in
quiet pools; living things come forth on to the land.

III

The chronicles of the ages are hers; the generations of
living things are numbered in her book; the records of
their origins are graven upon her tablets.
She knoweth how soon they end in labor and sorrow;
they go down finally into the grave.
She interpreteth the writings of the ancients: the wisdom of old is hers, and of the future she prophesieth.
By her the living are measured and the dead appraised:
Yea, they that have gone before live in her memorials;
for her labors endure from generation to generation.

IV

All the living creatures of the earth are sought by her:
she hath given them names and made known their place in the world.
To her nothing that is alive is of no value; the labors
of the ant are instructive, and the way of the bee worthy of remark.
She sheweth the antiquity of our descent: nevertheless our
forebears were akin to foolish apes, and their
forebears the smallest of the beasts of the field.

V

Yet are we not utterly without hope: for she hath declared
unto us a way of salvation.
She hath shewn us the reason for the sinfulness of man.
The origin of his perversity she hath made plain.
We may perchance correct our faults through her instruction,
and her teachings lead to humility and understanding.
So let us give praise unto Natural History;
for nothing on earth is too humble for her to study
and the splendor of the heavens is open before her.

Animals of Land and Sea

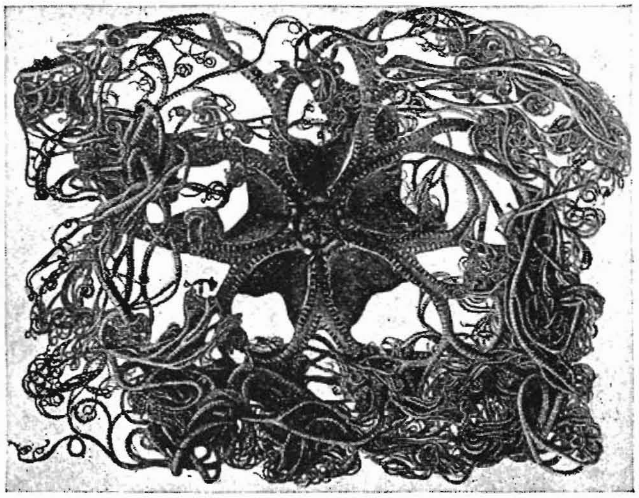
By PAULINE H. DEDERER

Professor of Zoology, Connecticut College

IF YOU have ever on a summer's vacation had the pleasure of exploring some rocky pine-girt island along our New England coast, you have probably seen, when the tide receded, many pools left among the rocks, forming natural and beautiful aquaria. In such tide-pools as these you may find in abundance starfishes of various sorts, their cousins the sea urchins encased in round spine-covered shells, tiny snails tightly fastened to the rocks (relatives of the Mediterranean forms whose bodies, when crushed, yield the Tyrian purple dye), sea anemones as big as apples, colored red, brown or orange, and thousands of barnacles, each animal secure within its white tent-like shell.

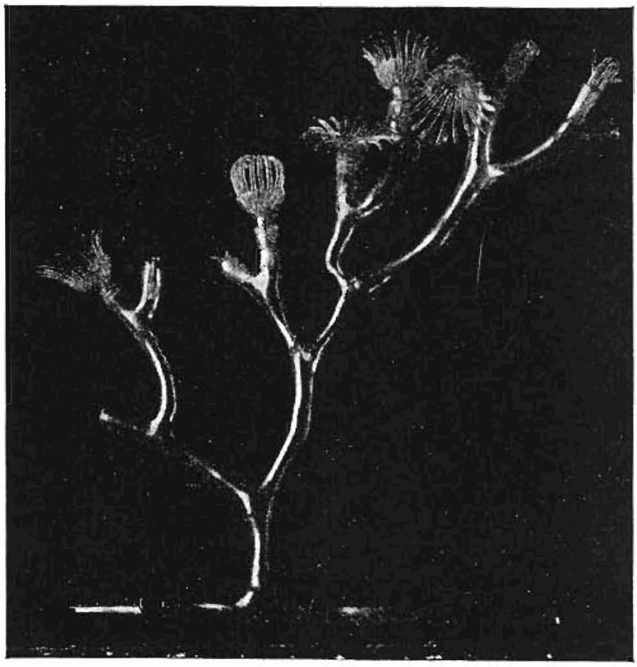
You will also probably find what you may imagine to be various kinds of seaweeds, which would prove to be beautiful sorts of animal communities termed hydroids, in which each individual, like a many-petaled flower, arises gracefully from a tiny transparent vase. If, however, a small lobster-like animal should dart that way, the waving tentacles would grasp and paralyze it, and finally pull it down into a central mouth, suddenly become capacious. The flower-like organism is plainly an animal, since it has the ability to feel, to move, and to digest food. The seaweeds, on the other hand, which they resemble so closely, show no sign of feeling, do not move voluntarily and are nourished by inorganic substances which they absorb from the water.

There are certain characteristics of living things, whether plants or animals, which mark them off sharply from their inorganic surroundings, the water, rocks or sand. These are: a peculiar chemical constitution, definiteness of organization, the power to repair themselves as their tissues wear



Courtesy American Museum of Natural History
A "Basket" Starfish

out, the ability to grow and multiply, and the ability to adapt themselves to their surroundings. Every living thing in this pool, for example, is composed of six chemical elements, always the same six, with which few or many others may be combined. If we should try to imagine a machine of some sort which could stoke its own engine, oil its own gears, repair a break, and finally reproduce other machines like itself, we should realize how remarkable are the powers of repair, of growth and reproduction in living things which we take so much for granted.



Courtesy American Museum of Natural History

A Hydroid Colony

Returning to our tide-pool we find many conspicuous examples of the way in which animals are adjusted with such intricate nicety to the conditions of their environment. To succeed in any environment, the animal must be able to secure food and oxygen, to protect itself from enemies or adverse conditions, and to reproduce its kind. Animals of different kinds, even in the same environment, meet these problems in various ways. The rock barnacle lives secure within its shell, the roof of which is tightly closed when the tide recedes. But if you splash the water in the pool, you may see the peak of the roof open, and small feathery processes reach out and wave about in the water to gather in food. The snails which crawl slowly over the rocks will at low tide pull themselves entirely within their shell, which may often be closed completely by a little horny plate, making them secure against attack or drought. Turn a starfish over, and it immediately sends out hundreds of thread-like projections which touch the adjacent rock; the threads shorten, and presto—the animal is right side up. Touch the crown of tentacles of the sea-anemone or try to pull it off the rock; the animal will contract into a slippery ball, and numerous stinging threads like white cotton fibers will protrude from many pores.

One other characteristic of living things remains to be briefly explained, namely definiteness of organization. A plant or animal body can be resolved into elements or microscopic units which are called cells. They are not little hollow cases, as the name implies, but extremely minute units of living matter called protoplasm, with a peculiar central body or nucleus. These cells are of different shapes, being much elongated in muscle and nerve cells, disc-like in blood cells, and spherical in egg cells. The living matter composing a cell appears under the microscope as a tiny mass of granular jelly-like material, containing the spherical nucleus, and surrounded usually by a thin membrane or cell-wall. It was of this fundamental protoplasm that Huxley wrote in his famous essay "The Physical Basis of Life". Many experiments upon cells have been made which demonstrate that the nucleus is essential for the life of the cell, and that certain peculiar bodies called chromosomes, which it contains, are the bearers of the hereditary characteristics from one generation to the next.

The animals that I have mentioned above make their home along the continental shelf, a sort of gently sloping extension of every continent, with relatively shallow water. Here is a region of turbulence, of movements of tide, of dashing surf, of warmth and sunlight and plenty of food. The shore is "noisy with the conjugation of the verb—to eat". Other regions of the sea also have their inhabitants. On the surface are myriads of tiny floating creatures, food for larger animals. Further down are the swimmers, great sharks and other kinds of fishes. Down in the remote depths live many kinds of strange fishes where no sunlight penetrates, where the pressure is enormous and the temperature is near freezing.

All these creatures, from their earliest history, have made the seas their home. But strangely enough, two of the most impressive types that swim the seas, namely the seals and whales, evolved from land animals and are really mammals as their body build shows, with only superficial resemblance to fishes.

Book Reviews

EXPLORING THE HEAVENS. By Clyde Fisher. 223 pp. New York: Thomas Y. Crowell Co. $2.50

Modesty is undoubtedly the reason why Clyde Fisher, Curator of Astronomy at the American Museum of Natural History for many years, responsible for the erection of the Hayden Planetarium and now its Curator, has not long ago published a book on popular astronomy. For a long time he has been in demand for lectures on the subject. For years he has been visiting the observatories throughout the world, four times he has taken part in solar eclipse expeditions. He has studied meteor craters right on the ground here and in Europe, and has helped bring together the finest collection of meteorites in the world. Yet this is his first book on astronomy.

It does not attempt the whole wide range of the subject, but limits itself very largely to the solar system, and to the stars only as the naked eye and the small telescope sees them. In short, it presents the subject much as the Planetarium can present it. Add chapters on the Origin of Our Solar System, and A Glimpse of Relativity, accounts of the great observatories, and of the Hayden Planetarium, rather full details on eclipse experiences and meteor craters, and you have a wholly delightful and clear account of the Earth and Neighbor Worlds, the Sun and Moon, Meteors and Comets, the changing seasons with their pageant of constellations and mythology.

As an introduction to modern astronomy the book is outstanding. It is especially to be commended for its many select and beautiful illustrations, including this year's solar eclipse, views of the Arizona and Esthonian meteor craters, a model of the mounting for the great new 200 inch reflector, and close-ups of the wonderful Planetarium projector. —*Allan Broms*

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BIOLOGY AND HUMAN BEHAVIOR. By Mark Graubard. 413 pp. New York: Tomorrow, Publishers. $2.50

The specialists on the subject throughout the scientific world are quite in accord that human behavior results from the interaction of that biologic organism, man, with his environment, which admittedly is not only physical, but social as well. Few, however, are both competent and daring enough to employ and apply this modern truism through all its implications. Dr. Graubard is in this sense exceptional; for he is competent as biologist and psychologist; and he does dare to follow through to the social implications of his studies. In fact he begins by calling attention frankly to the existence of both free and enslaved sciences, the latter being those in which free inquiry and teaching are restricted by established prejudices and vested interests. Obviously, these are primarily the economic and social sciences, whose professors must needs walk softly lest they tread on influential toes. For himself, he insists on freedom at any personal cost, and thinks and writes accordingly.

After an excellent introduction on The Method of Science, he devotes three chapters to The Animal and Its Environment, giving a most explicit summary of our knowledge of living matter, neural reactions, conditioned reflexes, functioning of sense organs, dynamic equilibriums and physiologic buffering, in short the essential modern description of the living and reacting organism. Three equally explicit chapters sum up and clarify the intricacies of cell structure and functioning, the physical basis of heredity in chromosome and gene, the nature and origin of mutations, and our resultant clearer understanding of natural selection and the process of evolution.

To this point the book is just another excellent exposition of recognized modern knowledge. But from this point on the book becomes dynamic and significant. "Human Nature" becomes a realistic, living result of inherent capacities shaped by educational conditioning, and reacting to the impacting stimuli of diverse, often changing, environments. "Human behavior" ceases to be a phrase and comes to life; one realizes that the author is talking about things as they are. One understands better why others have failed to attain such realism when the author gives the Freudian Mythology a piece of his scientific mind, chides the Behaviorists for evasion of social realities and puts his critical finger very precisely on the weakness of the Eugenists and their "program". That weakness turns out to be racial, caste or class prejudice, the myth of self-assumed superiority. That myth or bias is implicit in whatever social and economic arrangements may exist, and will persist while privileged castes, economic classes, imperialistic nationalisms and like social inequalities demand defense and sanction from obsequious professors of science. The daring author concludes quite rightly that the full human potentialities for achievement, and more specifically for socially considerate behavior, cannot even be learned, much less realized in fact, until inequalities of economic and related privilege have been removed from the earth.

—*Allan Broms*

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THE ADVANCING FRONT OF SCIENCE. By George W. Gray. 364 pp. New York: Whittlesey House, McGraw-Hill Book Co. $3

Inevitably this up-to-the-minute book-length report of the news of scientific discovery was chosen as the current selection of the Scientific Book Club. Their Review Committee rightly describe it as "a truly thrilling account in simple, revealing language, of contemporary progress all around the expanding horizon of knowledge. No living reporter is better qualified than Gray to present the current news of scientific research in terms that convey the meaning and spirit of the endeavor without indulgence in false emphasis or sensationalism." By thus quoting unstinted praise from a critical committee of authentic scientists, this reviewer hopes to avert the suspicion of extravagance in the flattering opinions he must give of this outstanding book.

Above everything, it attains the first quality of popular scientific writing, complete lucidity. It presents each problem so fully and clearly, yet with only a necessary minimum of historical setting, that the new researches and achievements are revealed in all their theoretical and practical significances. This is therefore no mere reporting of a miscellany of scattered news-facts, but an entirely coherent account of the concerted advances on many fronts of the increasingly interlocking body of knowledge which we call "science". That we conveniently divide it into fields of physics, chemistry, astronomy, geology, biology, psychology, etcetera, no longer hides the underlying fact that the multitude of apparently diverse natural laws which science studies are interrelated basically.

The author is particularly to be congratulated upon an unusual capacity for popularization without distortion of scientific attitude. This appears not only in the absence of sensationalism, but in the presence of true explanation. So many science popularizers succeed only in telling "what it is about", leaving the reader ignorant of the actual (usually technical) explanation itself. But here one gets insight into the reasons for things, with the technicalities rendered into such simple language that one reads on without even the consciousness that these are difficult problems. Of course there are technical problems quite beyond popularization even by the skill of Gray, but there is nowhere that exasperating pretense of explanation of which so many other popularizers are guilty.

The up-to-dateness and authenticity of the book are secured by Gray's method of gathering his news. He has gone directly to some seventy-odd scientific workers in laboratories and observatories, and from them has drawn the story of what is new and important in scientific research.

Necessarily there had to be selection of material, and the only fault one finds is the omission of several fields in which fruitful and vital research has recently been done. As it stands, the book deals largely with physics, chemistry, astronomy, geology, biochemistry and medicine. Archeology, anthropology, psychology and the social sciences have perhaps, in the author's opinion, not made significant advances in recent years. At any rate they have not been included in his story. However, in his concluding chapter, "The Promise of Science", he does drive home the fundamental part that science has and must ever play in solving our problems, physical and mental, technologic and social. Within the limits of nature's law, man, through science, is free to mold his future. In the effective and proper shaping of that future of mankind, he insists on the basic importance of widespread education in science, and (quoting Pavlov) on the "omnipotent scientific method". —*Allan Broms*

The Research Front

Speeding Up Evolution

DISCOVERY of a method of causing evolution was announced at the recent meeting of the National Academy of Sciences by Dr. Albert F. Blakeslee, Director of the Station for Experimental Evolution of the Carnegie Institution of Washington.

For some time it has been known that, among animals and plants alike, parents transmit their traits to their offspring by means of chromosomes, little "threads of life", on which the real heredity bearers, the genes, are located somewhat like tiny beads on a string. A set of these chromosomes is inherited from each parent, carrying a full complement of genes for transmitting all the various characteristics of the parent plant or animal. These merge, and in that merger the characteristics of the offspring are determined. If nothing has happened to change the genes, then "like begets like" and the children will be like their parents.

But we know that heritable variations, or mutations, do occur in nature. The young are not always like the old. A great many instances have been observed where new characteristics have come into being. Such mutations occur when something has happened to the genes, causing them to transmit to posterity a message different from that received from their ancestors. Plant and animal breeders are constantly on the lookout for suitable mutations with which to "breed up" seed and stock.

How to affect the genes and cause mutations artificially and thus speed up evolution is a problem that has challenged the attention of scientists for a long time. In Volume III, Number 1 of EVOLUTION, Dr. H. J. Mueller described a method for bringing this about by means of X-rays. Scientists in many Agricultural Colleges are now experimenting on various plants with this method.

Dr. Blakeslee experimented along a different line. He tried out the effect of various chemicals in his effort to induce hereditary mutations. And he found that a chemical, *colchicine,* would cause mutations in plants, doubling the chromosomes and genes, (distinguished from mutations due to changes within the genes).

He reports: "The alkaloid colchicine we have found will induce an abundant production of branches with doubled chromosome number. When seeds are heavily treated all the seedlings may be affected. Doubling in adult tissue has been induced by immersion of twigs in solutions and in agar, by treatment of buds with mixtures of colchicine and lanolin and by spraying with solutions. By the use of colchicine changes have been induced which are interpreted as being due to doubling of chromosomes in the following genera: Datura, Portulaca, Cosmos, Phlox, Nicotiana, and several others.

"If control of chromosome doubling proves of general application, as seems to be the case, the plant breeder will be able to work with greater precision in his efforts to control the evolution of economic forms of plants propagated vegetatively as well as those produced by seed. Starting with a sterile hybrid, a pure breeding double diploid has been synthesized, having hybrid vigor and the desirable characteristics of tetraploidy. Doubling the chromosome number would give enlarged flowers and fruits to the horticulturist. In addition to increase in the size of the organs of plants, doubling the chromosome number has changed a self sterile to a self fertile form, changed a dioecious to a hermaphroditic race and an annual into a perennial, and has increased winter hardiness. In Zoology the causing of chromosome doubling is an unexplored field, but it will probably be a fertile one. The ability to induce chromosome doubling therefore is of importance to practical as well as theoretical genetics."

(In an early issue Evolution will bring its readers more details regarding Dr. Blakeslee's epoch making discovery.)

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The Borderland of Life

TWO reports made at a Symposium on Biophysics, just held at the University of Pennsylvania under the auspices of the American Institute of Physics and the Eldridge Reeves Johnson Foundation for Medical Physics to apply the findings of modern physics to solution of biological problems, will be of special interest to readers of EVOLUTION.

Dr. Wendell M. Stanley of the Rockefeller Institute for Medical Research, who achieved fame two years ago with the successful isolation in crystalline form of the virus that causes tobacco mosaic disease, reported the isolation of two viruses causing disease in animals. Like the virus of the tobacco mosaic disease, these viruses are not small living bacteria, as had been supposed, but giant protein molecules, resembling the ordinary protein molecules of protoplasm but larger, and having the life-like ability of reproducing themselves rapidly when in contact with living matter.

It appears that in these viruses Dr. Stanley has discovered forms that exist in the "twilight zone" between the living and the non-living, having certain properties of each, but belonging to neither. They help to bridge the gap between the organic and the inorganic worlds. They furnish one of the most important "missing links" that fundamentalists have always challenged the evolutionists to find.

The study of these invisible forms, so small that they pass through the finest porcelain filters, but capable of causing many of the most serious diseases in plants and animals, has occupied men of science for many years. But not until Dr. Stanley isolated the tobacco mosaic virus was their nature definitely understood. They are molecules of protein, similar to the protein that exists in all protoplasm, but in a suitable environment they seem to "come alive" and reproduce their kind indefinitely.

"In view of the properties which this protein possesses," says Dr. Stanley, "the borderline between the living and the non-living tends to become non-existent, for although it possesses properties which have been regarded as characteristic of living things, such as specificity of host-range and the ability to reproduce and mutate, it is nevertheless a protein molecule, and as such may be regarded as non-living."

To the evolutionist one of the most interesting features of this protein molecule is that, in common with all forms of life, it is subject to mutation, and therefore to the process of evolution. Such virus mutations have already been observed in nature, and have even been brought about artificially in the laboratory by chemical means. Through mutation a virus growing in connection with one kind of plant becomes adapted to existence on another plant, or capable of producing a different disease from its ancestral virus. This protein molecule seems to be closely akin to the gene, the heredity bearer, through which the traits of living forms are transmitted from generation to generation. It may be that here we have the key with which to unlock one of the doors to the mystery of life itself.

When Dr. Stanley reported on his work with tobacco mosaic virus about a year ago he expressed the hope that the viruses that cause diseases in animals and man would also yield to the technique he had developed. Success has now crowned this effort.

Other scientists of the Rockefeller Institute, including Dr. Carl Ten Broeck and Dr. Thomas G. Wyckoff, have now isolated the virus that causes equine encephalitis, a horse disease similar to human sleeping sickness, and the virus causing warts on rabbits. Both of these viruses are also giant protein molecules, but they differ enough so that each causes only its own peculiar disease.

It seems probable that certain diseases have their origin in the mutation of some protein molecules from their ordinary harmless forms into forms that are harmful. Again, certain viruses that produce disease in one plant are harmless to other forms of life. Dr. Stanley reports that the virus which causes ring disease in tobacco also exists in the potato, but does no harm, either to the potatoes or to the humans who eat them.

It has also been discovered already that by certain chemical methods these virus proteins can be rendered inactive, but still capable of giving immunity. Thus an entirely new road to the study and conquest of certain diseases opens up.

"The sole objection" says Dr. Stanley, "to the final and complete acceptance of virus proteins as protein molecules is that, although an analogy of a protein reproducing itself in the test tube is known, the self-production of a protein in the living cell is today not an accepted chemical reaction. Immediately we are forced to the inside of a living cell we are faced with a set of conditions that we have not fathomed as yet. The virus protein is apparently imbued with something of which today we are ignorant.

"Knowledge of the mechanism by means of which a given huge molecule-like protein, when introduced in a certain cell, is able to bring about the organization of the amino acids and cellular constituents, with formation of exact duplicates of the introduced entity, is of tremendous importance, for this mechanism is the basis of biological activity.

"The virus proteins, because of their abundance and stability, furnish us with adequate working material for a study of this mechanism."

What Snares Sun-Energy?

EVERY school boy has heard that chlorophyll makes plants green, and that by means of chlorophyll the energy of sunlight turns water and carbondioxide into plant substance, thus creating the primary food upon which all animal and human life depends.

Now comes Dr. Ondess L. Inman, director of the Charles F. Kettering Foundation for the Study of Chlorophyll at Antioch College and tells us that this is not quite correct. No scientist knows as yet exactly what chlorophyll is and just how it does this work of turning inanimate matter into living substance, without which none of us could exist. But in common with a great many other research workers Dr. Inman has been studying this matter, and he has just found out something that no one knew before and that may prove to be of tremendous importance to the future of the human race.

He has discovered that the extracted chlorophyll, which is being studied in the laboratories is not quite the same as the chlorophyll as it exists in the green plant, and that there is another substance within the chlorophyll of living plants that serves as the actual harnesser of the sun's energy. This substance seems to be destroyed in the chemical process of chlorophyll extraction, but he has proved its existence by means of the spectroscope and also by various chemical tests. But he has not yet succeeded in "isolating" it, so that we can not yet be sure about its nature. Dr. Inman says that it appears to have a relation to the chlorophyll similar to that of the protein molecule globin to the hemin in the blood, forming the more complex hemoglobin, and that it probably consists of a protein and a fat.

A high speed ultra-centrifuge will now be used to "isolate" this newly discovered substance from the chlorophyll. This process is a little like that of the common cream-separator, which "isolates" the cream from the milk. This is the same apparatus with which the scientists at the Rockefeller Institute for Medical Research have isolated the tobacco mosaic virus and proved it to consist of extra large protein molecules.

If this experiment is successful it may have far reaching consequences. It may enable us to learn how to do artificially this work done by green plants of storing up the sun's energy, and how to make starches and sugars out of inorganic materials.

The Shasta Daisy

By GARNETT RUSSELL BRIGHT

EXPERIMENTING with the American daisy many years ago, Luther Burbank noticed that one bush had whiter blossoms than any other of the thousands that he had cultivated. With this plant Mr. Burbank began fifteen years of effort to produce a daisy of the purest imaginable white.

First he crossed the American ox-eye with its English cousin by taking pollen from the English daisy and fertilizing the American daisy. Flowers from the seed thus produced were larger and bloomed earlier than either parent, but all had a yellowish tinge instead of the pure white that he wanted.

Next he crossed this hybrid with the German ox-eye, which made only a slight improvement. After five or six years of selecting the best of this hybrid with its three parents he succeeded in raising a much superior daisy, larger and more beautiful in form and just as rugged and prolific, but still lacking the snowy whiteness.

Then he learned of an Asiatic daisy, a coarse plant with an ugly leafy flower, which had the quality he wanted: it was pure white. He obtained seed of this daisy from Japan, brought it into blossom and crossed the pollen with his best hybrid daisy, the product of three parents and many years work. The first season's bloom from these seeds were disappointing, but the second season one plant had flowers as beautifully white as the Japanese daisy, larger than the largest ever brought into blossom. It also had the grace of the American plant and was as vigorous and hardy as any of the four.

Each year for several years he raised thousands of seedlings having these four ancestral strains from three continents, kept the best plants each season and destroyed the others, until at last the wonderful flower known as the Shasta Daisy was produced.

Having succeeded in this, Mr. Burbank proceeded to cultivate slight differences in his various blossoms until now the Shasta Daisy has several strains. The Alaska has larger and more numerous blossoms and longer stems than the original or parent Shasta. Westralia has blossoms of even greater size and very long stems.

It is true that these variations have arisen under artificial conditions; but it is also true that there is nothing in these conditions that may not also occur in nature.

Nature Study Notes

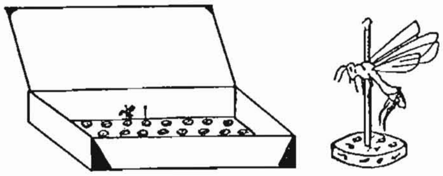
Monthly Feature for Study Groups

By Nathan S. Washton
Merit Badge Counselor, Nature Study, Boy Scouts of America

COLLECTING INSECTS

THE reader should make a collection of insects for study. An economical method for preserving specimens, suitable for the beginner, is as follows: On the bottom of a cigar box or similar box glue some strips of corn-pith, or slices of large cork stoppers, into which pins can easily be stuck.

Pin the collected insects to the cork, leaving the head of the pin sufficiently above the insect to grasp it with the fingers. Be careful not to have the insect too far down on the pin, as its legs would touch the box and break off.



Insects may be killed by immersing them in alcohol for a few minutes. Butterflies and moths may be killed by pressing the body with thumb and forefinger just enough to kill without crushing them. The fumes of benzine or ether will also kill insects.

It is best for several friends to go together in search of specimens, as the activity and success of one will encourage the others. Good places for collecting are the waysides, borders of woods, gardens, fences, lakeshores, brooks, under stones and stumps, the bark of fallen trees, or beneath the layers of dead leaves.

EXAMINING INSECTS

Observe that insects having three pairs of legs have the body divided into three parts, the head, thorax and abdomen, and that with few exceptions they have wings. These are called *True Insects,* or *Hexapods,* meaning "six legs". The ant, fly and wasp have the three parts of the body distinctly separated, but in certain beetles they are so close together that it is difficult to distinguish the dividing line. Examine at least four different types of insects and note the head, thorax and abdomen.

Find the *mouth,* the *eyes* and the *feelers* or *antennae.* The mouth is on the under side of the head. It parts vary greatly in different insects. In those that chew their food, such as beetles and grasshoppers, some of the mouth parts serve as teeth or jaws, and, being joined to the right and left sides of the mouth, move sideways and not up and down as in other animals. In the bugs proper some of the mouth parts are very sharp and slender, forming a long sharp sting to suck the juices of plants. In butterflies they form a long slender tube for sucking the nectar of flowers.

In the common house fly the mouth parts appear as a proboscis, a fleshy appendage which is bent up when not in use. Watch a fly as it feeds. Its proboscis is unbent, and the food is lapped up by it.

In the butterfly and moth, observe the long tongue, looking like a watch spring. It may be uncoiled with a pin. On the front of the head are two feelers or antennae. These are variously jointed, and vary greatly in different insects. In butterflies the antennae are generally long and slender and swollen at the tips, resembling drumsticks. In some moths they are barbed on the sides and look like feathers.

On the sides of the head are round smooth places, the eyes, entirely different from the eyes of other animals. Under the microscope they are seen to be divided into little spaces, like the surface of a honeycomb. Each little space represents an individual eye. Some insects have hundreds or even thousands of these little spaces or eyes, called *compound eyes.* With the microscope you may see three minute dots under these compound eyes. These are called *simple eyes.* In many insects, as in Dragon flies, the compound eyes are very prominent, enabling them to look backwards as well as forwards.

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Darwin and the Beetle

"No pursuit at Cambridge gave me so much pleasure as collecting beetles. It was the mere passion for collecting, for I did not dissect them, and rarely compared their external characters with published descriptions, but got them named anyhow. I will give proof of my zeal: one day, on tearing off some old bark, I saw two rare beetles, and seized one in each hand; then I saw a third and new kind, which I could not bear to lose, so that I popped the one which I held in my right hand into my mouth. Alas! it ejected some intensely acrid fluid, which burned my tongue so that I was forced to spit the beetle out, which was lost, as was the third one."—From Charles Darwin: Autobiography and Letters, Edited by his son, Francis Darwin.

Mosquito Music

SOME time ago under the heading "Mosquito Ignores Darwin" the N. Y. Herald Tribune published without comment the following epistle from one Richard Lester:

> "Last night I was awakened from my slumbers by a familiar jewsharpian sound approaching my right ear. When I felt a hairlike touch on my face I whacked, and another Jersey mosquito bit the dust.
>
> "It occurs to me that the song of the mosquito, far from aiding said species to survive, helps them to reach mosquito heaven sooner. Why is it that in the struggle for mosquito existence the singing variety haven't long ago been selected out as less fit, and silent mosquitoes been left to inherit the earth and me? That's the way things are supposed to happen, according to the best evolutionary doctrines of Charles Darwin. Can it be that the tunes struck up by this tiny creature, as it wings its way earward, disprove Darwin's venerated doctrines?"

Nay, nay, friend Lester, it can NOT be. That buzzing sound seems to be an important feature of the love-life of the mosquito, whereas whether you whack a mosquito more or less is of but little moment to the mosquito species. Dr. C. H. Curran, entomologist of the American Museum of Natural History tells us that the buzzing sound serves to attract the male mosquito. Of all the billions of mosquitoes that buzz, only now and then one is heard and whacked by a human being. Most of them suck juices of plants or animals not so well equipped for mosquito whacking as man.

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The Monkey's Paw

Two men argued evolution;
Its believer nothing said,
But he used good elocution
When he scratched his itching head.

Elmer William Gardnier.

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Fundamentalist Follies

CLERICAL EMBRYOLOGY

By E. T. Brewster

IT'S old stuff; but it turns up again, quoted by the *Bible (Ex)-Champion,* that is now a portion of *Christian Faith and Life* (*Apr.* 1931, p. 182).

"There are radical differences between the embryos of vertebrates and invertebrates. Worms and other articulates in embryo lie doubled backward around the yolk, while all vertebrates are doubled in the opposite direction. According to the theory that the embryonic condition is a recapitulation of the stages of organic evolution, this fundamental fact of invertebrate embryology ought to have been preserved by the vertebrate. Evolution gives no account of this reversal of position by the vertebrate."

Of course, it is not true that "all vertebrates are doubled in the opposite direction"—as any bright undergraduate who has begun embryology could have told the two Doctors of Divinity who are perpetrating this particular piece of Fundamentalist nonsense. The most important branch of the vertebrates for us, namely the higher mammals, have almost no yolk to their eggs and so can't double round it either way.

Neither do most "invertebrates." The fact is, what our D.D.'s, following the zoölogy of a century ago, lump together as "invertebrates," really comprises no fewer than fifteen of the great divisions of the animal kingdom, each of them equivalent as a system to all the vertebrates together. So there is, naturally, nothing whatever that can be predicated of "the embryos of invertebrates" beyond the not very illuminating fact that most of them do reproduce in some way. Most "invertebrates," like all mammals, have minute eggs with no yolk mass. Naturally, they do not "double round" what does not exist.

Nevertheless, certain "worms and other articulates," in particular, the insects, really do "lie doubled backward around the yolk"—unless one prefers to call it that the "articulates" double frontways, and that such vertebrates as double at all, bend the wrong way.

But who except a Fundamentalist has ever supposed that the vertebrates are descended from any insect? What point, then, in the way either doubles round its food supply?

Both the insects and the vertebrates are, indeed, supposed to be descendants of a common ancestor. But all evidence goes to show that this common ancestor was very much too primitive a creature to have provided his offspring with any sort of ample food supply. His embryos, if they had yolk masses, might puzzle "evolution". But they did not. So why bother?

Both vertebrates and insects, then, start from an ancestry with small eggs. The embryos themselves have evolved along with the adults. Both, quite independently, have evolved large eggs with abundant yolk. Why, then, should anybody but a Fundamentalist D.D. expect to have the two doubled round their food-supplies in the same way?

Funnymentals

"I believe what I was taught, and I don't think that I ought to think." Argument of a Fundamentalist refusing to subscribe.

"Evolution is a fraud. It is a blank unproved theory, unsupported in fact. It is illegal to teach it in tax supported schools. Under the common law it is blasphemy." Rev. L. S. Hoover, at Free Methodist Church, Ithaca, N. Y.

"The Christian Church must repudiate the most subtle and monstrous lie that the devil has ever thrown into the face of the Son of God, and drive the whole diabolic spawn of evolution into the nethermost depths of hell where it belongs, when finally the Angel of the Apocalypse puts the lid upon the pit and bottles up the whole pestiferous tribe, there to await the final judgment of an insulted God." Rev. Levi Bird, quoted by San Antonio Bible Institute.

Boners From Exams

Isostasy is the place where earthquakes come from.

The chief argument against the nebular hypothesis is that it would make the sun revolve around the earth every few minutes.

Food that is not used leaves the body as a foetus.

The law of recapitulation: Animals are recapitulated by immigration.

Mosaic vision was the vision Moses had in the wilderness.

Darwin was a very famous man because he discovered the science of relativity and wrote a book on it.

Cuvier made a careful study of all elephants extant, and proved that they were totally different from fossil shells.

Bricks and Bouquets

"I consider EVOLUTION a cheap, nasty little magazine, and one that would militate against frank and open discussion of any problem. I am most sorry that it is going to be revived. As for some of the names on your staff, I have watched them for years, trying to prove that they are an improvement on the ape, and I haven't found that they have established their cause." *William Procter.*

"I enjoyed the first number of the new series. If future numbers will carry the same message and adhere to a similar high standard, the journal is bound to succeed." *Wm. C. Darrah.*

"You are one of the best examples of perseverance I have ever met, and we need you to inspire us when skies are dark and faith is weak. May success crown your efforts." *Oswald Schlockow.*

"I recently received EVOLUTION—Got a glimpse of it only, when some thirsting soul also glimpsed it and put it in his pocket. He has good judgment, may it do him oodles of good." *W. T. DeCoster, M.D.*

"Congratulations on your resumption of the publication of EVOLUTION. Wish you all the success you deserve." *Theodore C. Abell.*

"Am glad you did not pussyfoot in naming the mag. Evolution is an established fact, and there is no use beating around the bush when speaking of it. Seems to me if you had more of the criticisms and carping allusions from ministers and others it would make more popular reading. Take a good healthy whack at them like Ingersoll used to do. Some of them can call names, but they can't really answer the evidence for evolution." *A. L. Faunce.*

"Please do me a favor and discontinue sending EVOLUTION. To my ethics it is very disgusting and anarchistic. Whoever had the audacity to send you my name must be some poor simple minded creature, whose weak mind was easily turned by the absolute rot and fairy tales contained in your magazine. Here's to your complete failure." *Mrs. John Borkosky.*

"I am very glad that you are again able to take up your fight against ignorance and superstition. Never was such a fight more necessary than now." *Harrington Johnston.*

"EVOLUTION should be placed in every school and library, as well as in the homes. I sincerely hope for the success of your efforts in placing before the people the facts disclosed by research, and helping to break down the prejudice which is so prevalent." *Elza E. Hadley.*

POOR LITTLE MONKEY?

They tell me man from monkeys came,
With this I might agree.
But, Gosh all Friday, it's a shame,
Or seemeth so to me,
To class a monkey with a man.
Here I arise to say
It isn't fair, denounce the plan;
I just stand for 'fair play'.
What has a monkey ever done
To merit such abuse?
He lives as Nature's loving son;
Fashions no creeds obtuse;
He doesn't smoke, he doesn't chew,
Nor drink 'white mule' or beer,
And to his mate he's kind and true,
Nor rules his child with fear.

He doesn't work for any "boss",
Out in his forest, wild,
But shares his gains, likewise his loss,
With kindred undefiled.
He never built a "private" fence
Around his cocoa tree,
Nor put up signs "Keep off the Grass!".
In Nature he is free.

The monkey, far as I can see,
Has lived life as he should.
You say man *came from* monkey?—Bah!
That theory is no good.
At least—if it is really true,
Get ready, pack your sack,
For I am sure that I can show
We really should *GO BACK.*

Guy Lockwood.

Please note our new address:

29-46 Northern Blvd., Long Island City, N. Y.
where EVOLUTION has established an office. This is at Queens Plaza, near all subways. Phone: Stillwell 4-8172.

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